Design & Modification of Shovel in Five Tyne Cultivator using Finite Element Analysis

A.Inbasekaran[1], Hariprashant R[2], Gowsigan M[3], Gopi C[4], Hari prasath M[5], Jeberson C[6]

[1]Assistant Professor, Dept. of Mechanical Engineering ,Dhirajlal Gandhi College of Technology, Salem, Tamil Nadu, India.
[2]Student, Dept. of Mechanical Engineering ,Dhirajlal Gandhi College of Technology, Salem, Tamil Nadu, India.
[3]Student, Dept. of Mechanical Engineering ,Dhirajlal Gandhi College of Technology, Salem, Tamil Nadu, India.
[4]Student, Dept. of Mechanical Engineering ,Dhirajlal Gandhi College of Technology, Salem, Tamil Nadu, India.
[5]Student, Dept. of Mechanical Engineering ,Dhirajlal Gandhi College of Technology, Salem, Tamil Nadu, India.
[6]Student, Dept. of Mechanical Engineering ,Dhirajlal Gandhi College of Technology, Salem, Tamil Nadu, India.

***

Abstract - *In last few decades we all witnessed the development in each and every field. In the field of agricultural also we had seen remarkable development, big farmers are now a day's using cultivator, harvester, tractor, advance machine tools and advance farm equipment's, but in the country like India where more than 80% of farmers are small and marginal and they are still doing farming by traditional method only they are also in need of improved agricultural tools that may be hand driven or bullock driven. In this paper the FEM analysis of five Tyne medium duty cultivators is presented.*

The main objective of this analysis is to increase the life of shovel. The existing cultivator which is manufactured by local small scale manufacturer gets failed at different points after approximately one session of uses. To analyze this Shovel using FEM, firstly a proper CAD model has been developed using Pro/E cad software. Then by using ANSYs software FEM analysis have been done to determine the stresses.

Key words: *Five Tyne Cultivator, FEM, Design Analysis.*

1. INTRODUCTION

India is an agricultural country and about 80% people in India are farmers and uses agricultural equipment like cultivator, rotavator etc. In each and every sector development is done but as compare to other sector in farm equipment development is not done. A cultivator is a type of farm implement used for secondary tillage. One sense of the name refers to frames with teeth also called shank or shovel that pierce the soil as they are dragged through it linearly.
The tools cultivator which they are required mostly manufactured in small scale industries or by local artisans like carpenter and blacksmiths. The present technique of manufacturing of agricultural tools by all these people is like design by evolution. The design is evaluate long span of time. The leisurely pace of technological change reduced the risk of making major errors. The circumstances rarely demanded analytical capabilities of the designer. Also this technique is unsuitable for mass production, difficult to modify, incapability to tap new technologies. The jobs made are not perfect, inefficient, health hazardous and very poor in quality in comparison to the parts made in big industry

2. DESIGN METHODOLOGY

- To study the Shovel original dimension in the Five Tyne Cultivator.
- To study of Shovel material used in the Tyne.
- After that the 3D Modeling of Shovel design should carried using PTC Creo Software and the file will be saved as IGES format.
- After the design for the shovel is completed now the analysis is also been carried for the shovel.
- Now during the analysis of shovel we refer that whether it with stands the load applied to it or not.
- If the shafts else not withstands the load then it is again sent back to design step and analysis carried. Until it with stands the load and satisfies.
- After the analysis is completed the analysis report is been generated and calculation are also been acts generated.
- Now the output results are been referred with the previous reports.

3. EXSITING MODEL

Tillage tools are directly energy in to the soil to cause some desired effect such as cutting, breaking, inversion or movement of soil. Soil is transferred from an initial condition to a different final condition by this process. Soil working tools such as mould board ploughs, disc ploughs and ridges have long been accepted and successfully used by farmer under average field condition. Seedbed preparation greatly contributes towards the overall cost of farm operations, employing that significant savings are possible through optimized design and development of tillage machinery.

Primary and secondary soil manipulation is the basic operation required for cultivation of any kind of crop. Soil manipulating tools should withstand adverse field conditions, such as the presence of a hardpan, small rocky formations stumps stable during soil engagement without failure. Soil working tools such as mould board ploughs, disc ploughs and ridger has long been accepted and successfully used by farmers under average field conditions. The duck foot sweep is another kind of soil engaging tool that is popular amongst farmers for secondary field operations because of its large wing width, which causes better coverage of soil manipulation between two furrows.

Fig-1 3D Model of Tyne

In the Fig-1, 3D model of the Five tyne Cultivator will be carried out by using PTC Creo software.

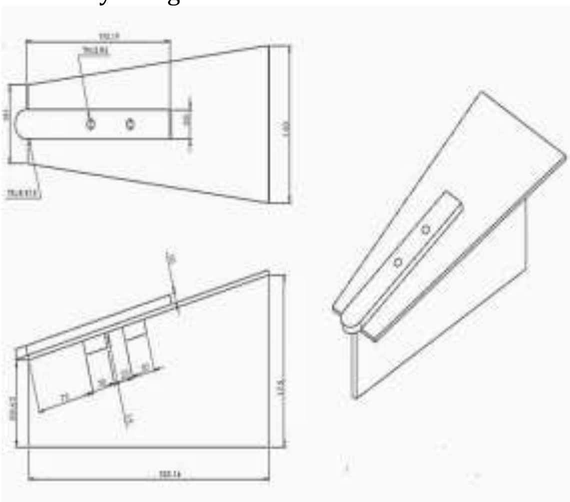

Fig-2 Existing 3D Model of shovel

In the Fig-2 modeling of shovel should be done by using PTC Creo and then the file will saved as IGES format.

Dimensions of Cultivator

Overall Length	-705mm
Overall Height	-579.65mm
Overall thickness	-60mm

The Existing material should be used in the shovel is Cast iron. the properties of the cast iron shows in the given below table 1.

Type of material – **Cast Iron**

Table 1 Properties of existing material

Young's Modulus	$0.8x10^6$ N/mm^2
Poisson's Ratio	0 to 0.5
Tensile Yield Strength	130 N/mm^2
Compressive Yield Strength	250. MPa
Tensile Ultimate Strength	460. MPa

4. SELECTION OF MATERIALS

Type of materials – **AISI 4130 low alloy steel**

Table 2 Proposed material properties

Young's Modulus	45 GPa
Poisson's Ratio	0.35
Density	2.35*10-6kg/mm3
Tensile Yield Strength	193 a

We select the AISI 4130 low alloy steel for changing of cast iron because of it have high tensile yield strength. and then we check the analysis of model of shovel by using Ansys workbench software.

5. INTRODUCTION TO ANSYS

ANSYS is general-purpose finite element analysis (FEA) software package. Finite Element Analysis is a numerical method of deconstructing a complex system into very small pieces (of user-designated size) called elements. The software implements equations that govern the behaviour of these elements and solves them all; creating a comprehensive explanation of how the system acts as a whole. These results then can be presented in tabulated or graphical forms. This type of analysis is typically used for the design and optimization of a system far too complex to analyse by hand. Systems that may fit into this category are too complex due to their geometry, scale, or governing equations.

The general steps to analyze the component in ANSYS software are as follows.

- Build geometry
- Define material properties
- Generate mesh
- Apply loads
- Obtain solution
- Present the results
- Specific capabilities of ansys

- Structural analysis
- Static analysis
- Thermal analysis
- Transient dynamic analysis
- Buckling analysis

6. RESULT & DISCUSSION

6.1 Calculation of force

Applying of Force
According to Newton's second law of motion
Force = Mass x Acceleration
F = m*(v/t) N
Mass = 500 kg, Time = 0.13 s
Velocity = 15 km/hr
F = 500*(0.228*15/0.13)
F = 16038 N
Nodes = 3944
Force = 4.06

6.2 Meshing of Modelling

At this point ANSYS understands the makeup of the part. Now define how the modeled system should be broken down into finite pieces.

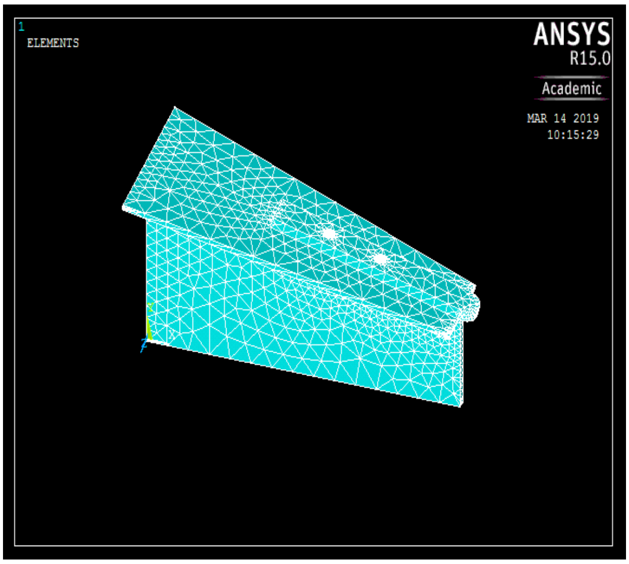

Fig-3 Meshing of Shovel

Now that the part exists, define a library of the necessary materials that compose the object (or project) being modeled. This includes thermal and mechanical properties.

Generate mesh

At this point ANSYS understands the makeup of the part. Now define how the modeled system should be broken down into finite pieces.

Table 3 Mesh details

Type of mesh	Coarse
Element size	500mm
Nodes	3944
Element used	Solid Brick 8 Node 185
Apply the load	4.5N

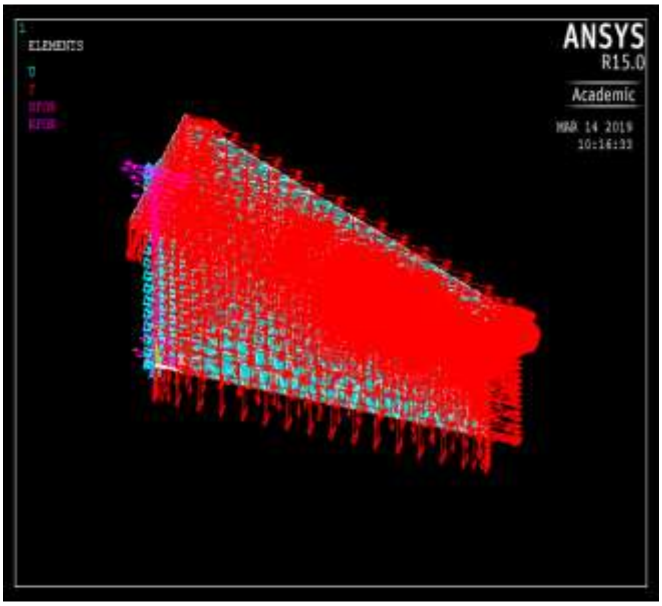

Fig-4 Applying Force and Displacement of Shovel

Apply loads

Once the system is fully designed, the last task is to burden the system with constraints, such as physical loadings or boundary conditions.

Table 4 Details of the load

Load acting on the direction	"x & y" direction
A	Fixed support
B **x- direction** **y- direction**	Force +4.06 N Force -4.06 N
Type of the load	Radial load

Obtain solution

This is actually a step, because ANSYS needs to understand within what state (steady state, transient… etc.) the problem must be solved.

Present the results

After the solution has been obtained, there are many ways to present ANSYS' results, choose from many options such as tables, graphs, and contour plots.

6.3 DEFORMATION OF EXISTING MATERIAL

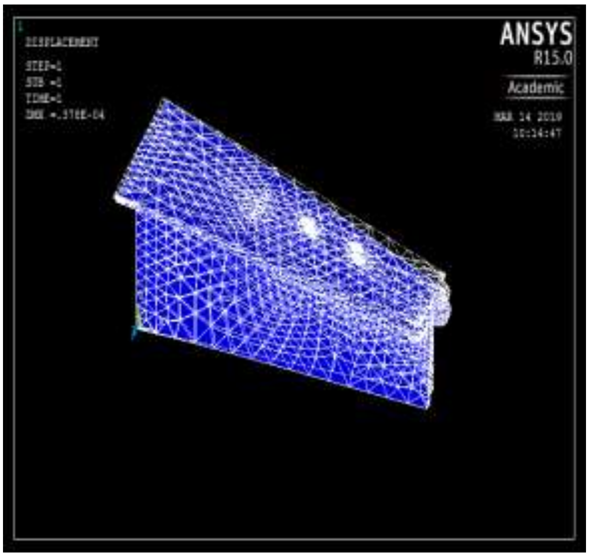

Fig-5 Deform shape of Shovel Existing Material

6.4 STRESS RESULT OF EXISTING MATERIAL

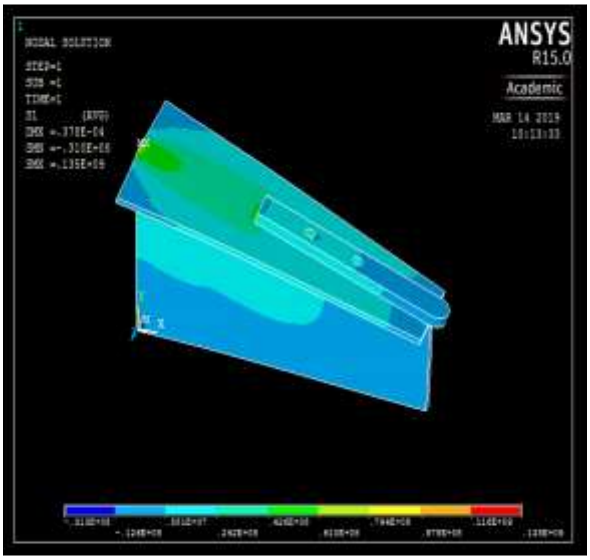

Fig-6 Shear stress of Shovel Existing Material

Von-mises minimum – -31 N/mm2
Von-mises maximum – 130 N/mm2

6.5 DEFORMATION OF MODIFIED MATERIAL

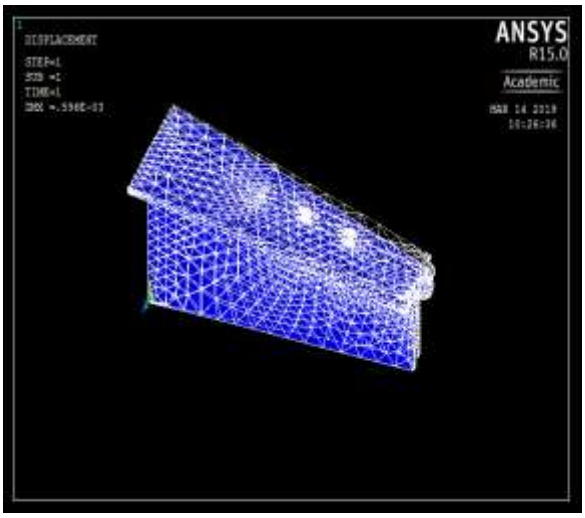

Fig-7 Deform shape of Shovel Modified Material

6.6 STRESS RESULT OF MODIFIED MATERIAL

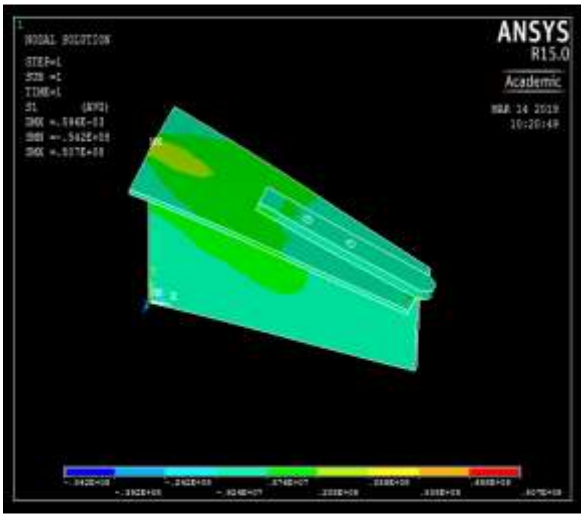

Fig-8 Shear stress of Shovel Modified Material

Von-mises minimum – -54.2 N/mm2
Von-mises maximum – 80.7 N/mm2

Table 5 Result of optimization of Shovel

Materials		**Cast Iron**	**Low Alloy Steel**
Type of stress		Von-mises stress	Von-mises stress
Stress (N/m2)	Max	**130**	**80.7**
	Min	**-31**	**-54.2**

7. CONCLUSION

From the result comparing between the existing material and proposed material we have less stress value. Hence we increase the life of the Shovel in the Five Tyne Cultivator by using AISI 4130 low alloy steel.

REFERENCES

1. Gopal U. Shinde1, Shyam R. Kajale2 “Computer aided engineering analysis and design optimization of rotary tillage tool components” 10.3965/j.issn.1934 6344.2011.03.001-006.
2. G. C. Kiss1, and D. G. Bellow2, “An Analysis Of Forces On Cultivator Sweeps And Spikes” Can. Agric. Eng. 23 77-83.
3. L.J. Niemand1 J. Wannenburg2 “Profile optimization of a cultivator shank” R & D fournal, 1995, II(1) page 7-11”.
4. Mehmet Topakci 1, H. Kursat Celik 2 “Deep tillage tool optimization by means of finite element method: Case study for a subsoiler tine,” Journal of Food, Agriculture & Environment Vol.8 (2): 531-536. 2010.
5. S. A. Al-Suhaibani1, A. E. Ghaly2, “Comparative Study of the Kinetic Parameters of Three ChiselPlows Operating At DifferentDepthsand Forward Speed In A Sandy Soil,” IJES. Vol 2 Issue 7 Pages 42-59 2013
6. R. L. Raper “Force Requirements And Soil Disruption Of Straight And Bentleg Subsoilers For Conservation Tillage System” Applied Engineering in Agriculture 2005 American Society of Agricultural Engineers ISSN 0883–8542 Vol. 21(5): 787–794
7. R. Bernik1 and F. Vucˇajnk2 “The effect of cultivator/ridger type on the physical properties of ridge, power requirement and potato yield”, Irish Journal of Agricultural and Food Research 47: 53–67, 2008.
8. S. Gebregziabher1 A.M. Mouazen2 “Design of the Ethiopian and plough using structural analysis validated with finite element analysis” Bio systems Eng I N E E R I N G 97 (2007) 27 – 39
9. U. R. Badegaonkar1, G. Dixit2 and K. K. Pathak3, “An experimental investigation of cultivator shank shape on draft requirement”, Archives of Applied Science Research, 2010, 2 (6): 246-255.