Design and Analysis of Rotavator Blade for its Enhanced Performance in Tractors

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Abstract – *The design and optimization of rotary tillage tool on the basis of simulation and finite element method is done by using ANSYS software. The different rotary tillage tool parts are geometrical constrained with preparation of solid model of blades and simulation has been done with actual field performance rating parameters along with boundary condition. The proposed work result are identifying sufficient tolerance in changing the material such a EN 8 steel and EN 24 steel. The dimensions of rotavator blade sections and to rise the life cycle of blades for a reliable strength. The present geometry working model with tillage blade is analyzed to new design. The changed constraints of its geometry for the maximum weed removal efficiency by presenting its analysis results from the field performance.*

Key Words: Structural Analysis, Deformation Analysis, Modal Analysis

1. INTRODUCTION

The rotary tillage machine has been used in soil bed preparation and weed control in the field of fruit gardening agriculture. The capacity of rotavator blade is large for cutting, mixing to topsoil preparing the seedbed directly. The mixing capacity is seven times more than that of plough.

The components works under miscellaneous forces due to power, vibration, pointless, impact effect of soil parts as after reaching to higher side. The manufacturing and design optimization errors can be minimised by its components design analysis and optimization.

The design optimisation of tillage tool has obtained by reducing its weight, cost, and improving a field performance to high weed removal efficiency. The analysis has been prepared a three dimensional solid modelling and applications of finite element method are getting widespread in the industry.

The undesired stress distribution components, it can not compensate to the operating forces in the field of environment and result in the breakdown and failure due to higher stresses and deformation.

The proposed work has developed a computer aided experimental system for design testing and valuation of agriculture tools and equipments. The selected physical model of rotavator has been measured with accurate dimensions and 3D solid model is prepared in CAD software such as CATIA, Pro-E, SOLID WORKS etc.

Fig.1 Rotavator with six Components

1.1 Research Objective

- To evaluate Structural Analysis
- To find out Deformation Analysis
- To evaluate Modal Analysis
- To Evaluate Soil test

2. LITERATURE REVIEW

Subrata Kr. Mandal and Basudeb Bhattacharya" Design and Development of rotavator blade: Interrogation of CAD method 2013". Blades interact with soil in different way than normal plots which are subjected to impact high friction which creates non-uniform forces and unbalancing which result in the wearing of blade. Therefore it is necessary that design and dilate(development) such a suitable model that will enhanced the self life. This paper deals with the design and development of rotavator blade through the interrogation of computer aided design(CAD) method.

Gopal U. Shinde and Shyam R. Kajale " Design optimisation in rotary tillage tool system components by CEA 2012." The design optimization of rotary tillage tool by the application of computer aided engineering(CEA)- Techniques on the basis of finite element method and simulation method is done by using CAD-Analysis software for the structural analysis. The different tillage tool parts of rotary tillage tools are geometrically constrained by the preparation of solid model, meshing and simulation is done with actual field performance rating parameters along with boundary conditions.

Rahul Davis "Optimization of surface roughness in wet turning operation of EN 24 steel 2012". The present experimental study is concerned with the cutting parameter optimisation(spindle speed, depth of cut, feed rate) in wet turning EN 24 steel(0.4%C) with hardness 40+2 HRC. In the present work, turning operations were carried out on EN 24 steel by carbide P-30 cutting tool in wet condition and the combination of the optimal levels of the parameters was obtained.

The Analysis of variance(ANOVA) and Signal-to-Noise ratio were used to study the characteristic of performance in the operation of turning. The results of the analysis show that no factors was found to be significant. Taguchi method showed that spindle speed followed by fee and depth of cut was combination of optimal levels of factors while turning EN 24 steel by carbide cutting tool in dry cutting condition.

N.M.Zarroug, R.Padmanabhan, B.J.MacDonald, P.Young, M.S.J.Hashmi " Mild steel(EN8) rod tests under combined tension-torsion loading 2003". The results obtained fro combined tension-torsion loading tests carried out on Mild Steel (EN8) specimen. The loading of the specimen was carried out in different methods: (i) Maintaining tensile force or axial displacement constant and increasing torque or angle of twist; (ii) maintaining torque or angle of twist constant and increasing load or axial displacement. A finite element solution of the problem was obtained to gain further insight into the effects of the loading modes.

Godwin R.J, M.J.O Dougherty " Integrated soil tillage force prediction models 2006". This paper revels the integration of a series of models to predict the forces acting on a range of tillage tools from simple plane tines to mould board ploughs. The models adequately reflect the changes in soil strength and implement geometry.

S.B.Venkatsiva, G.Srinivasarao, M.Mahesh Kumar "Study of phase transformations in EN8 steel material using acoustic emission technique 2012". By using online monitoring technique-Acoustic Emission(AE), Experiments are carried out distinguish the various phases. This work is aimed for better understanding of the growth mechanism and solid-state phase transformations that can occur in carbon steel(EN8). It is found from the experiments that the basic parameters by which the phase transformation can be found out are amplitude, RMS, counts and energy.

Khalid Usman, Ejaz Ahmad Khan, Niamatullah Khan" Effect of Tillage and Nitrogen on Wheat Cropping System 2013". Conservation tillage as well as nitrogen improves soil fertility, yield and income on sustainable basis. The aim of this study was to evaluate the impact of three tillage systems viz., Zero Tillage(ZT), Reduced Tillage(RT) and Conventional Tillage(CT) and Five N rates on yield and yield components , soil organic matter (SOM), total soil N (TSN) and income of wheat grow after rice.

Rahul davis, Jitendra singh Madhulkar " A parametric analysis and optimization of tool life dry turning of EN24 steel using taguchi method 2012". To obtain an optimal setting of these turning process parameters- feed rate, depth of cut, spindle speed, which may result in optimization of tool life of carbide P-30 cutting tool in turning EN24 steel(0.4%C). Turning operations were performed by carbide P-30 cutting tool under various dry cutting conditions by using sample specimen of EN24 steel.

By using Taguchi method, the effects of the selected process parameters on the tool life and the subsequent optimal setting of the parameters have been accomplished. The Analysis of Variance(ANOVA) and Signal-to-Noise(SN) ratio and were used to analyze the characteristic of performance in the operation of turning. The results show that Spindle speed followed by feed rate and depth of cut was the combination of the optimal levels of factors that significantly affect the mean and variance of the tool life of the carbide cutting tool provides the optimum tool life.

Sirisak Chertkiattipol, Tanya Niyamapa "Variations of torque and specific tilling energy for different rotary blades 2010". The torque characteristic and the specific tilling energies of three commonly used rotary blades, i.e. the Japanese C-shaped blade, the European C-shaped blade and the European L-shaped, were studied to develop a suitable rotary blade for seedbed preparation. The experiments were carried out in a laboratory soil bin at forward speed of 0.034 and 0.069m/s and rotational speeds of 150, 218, 278 and 348 r/min (or 3.30, 4.79, 6011 and 7.65 m/s) in clay soil and sandy loams.

Mahesh M. Sonekar, Dr. Santosh B. Jaju " Fracture analysis of exhaust manifold stud of Mahindra Tractor through finite Element Method(FEM) a past Review 2011". Failures of the designing the components with maximum stress value well below yield or ultimate stress can be observed. Tests carried out for time varying loads. Results obtained proves that the component fails at values below yield stress when subjected to time varying load. It can be pointed that below a specific stress value components are not failing at all.

This stress value was termed as endurance limit. For example yield stress for general steel is around 250N/mm^2 endurance limit 160N/mm^2 . At the outset, during application of FEM technique for failure analysis, a finite element routine would be first used to calculate the static and dynamic displacement. Stresses under the maximum compression and tension loading, which were then used for critical points evaluation.

3. METHODOLOGY

The proposed work results in identifying sufficient tolerance in changing the material (EN8 steel and EN24 steel), it is expressed in methodology as,

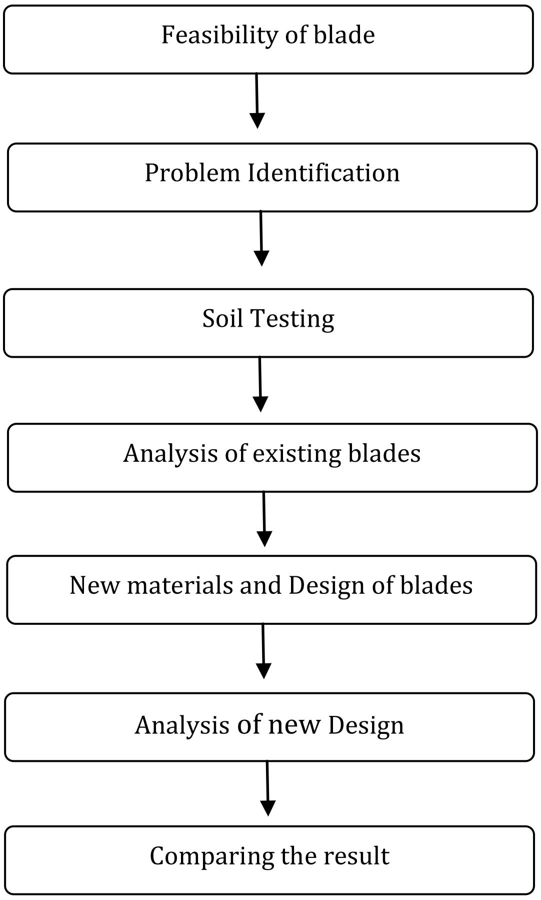

Fig.2 Methodology

4. EXPERIMENTAL WORK

Type of soil used for testing

- Black soil with Clay mix
- Black soil

Based among the 2 soils and density values has been taken for maximum tolerance limit.

4.1 Black soil with clay

The load values obtained for black soil with clay mix are,
Density = Mass of the soil / volume of core cutter
= 2.190/0.001453
= 1507.23 kg/m^3
= 1507.23 X 9.81 X 1.5
= 22178.89 N/ m^3
Load acting on the blade area = 600N

4.2 Black soil

The load values obtained for black soil are,
Density = Mass of the soil / volume of core cutter
= 2.060/0.001453
= 1417.76 kg/m^3
= 1417.76 X 9.81 X 1.5
= 20862.34 N/ m^3
Load acting on the blade area = 563 N

5. RESULT

From the analysis of rotavator blades, its observed that the stress value of the material is reduced by applying the design change and changing the material as, EN24,EN8 Steel, Mild Steel.

5.1 New Dimension of blades

A. With Radius 38

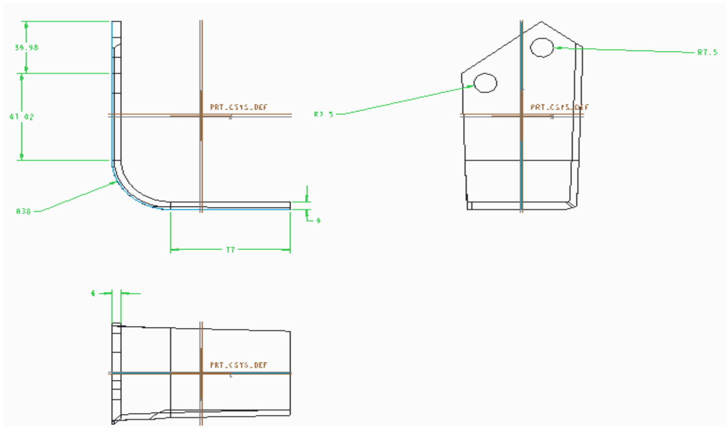

Fig.3 With Radius 38

B. With Radius 34

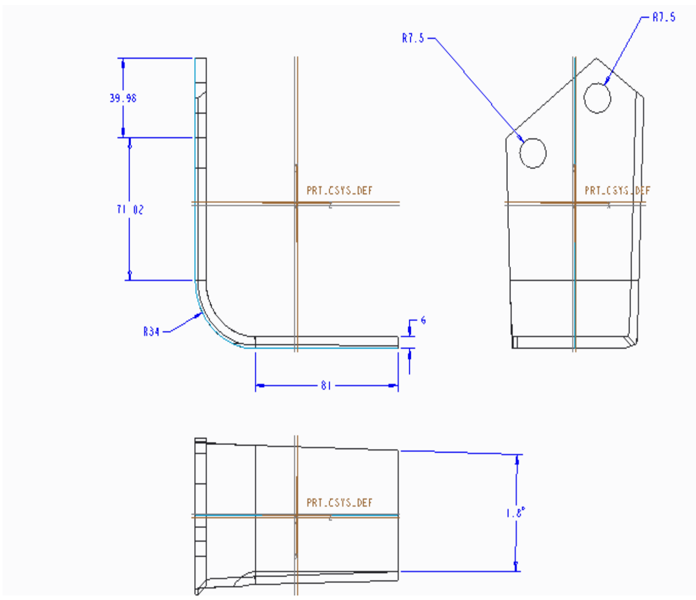

Fig.4 With Radius 34

5.2 Analysis of Blades

A. Deflection (mm)

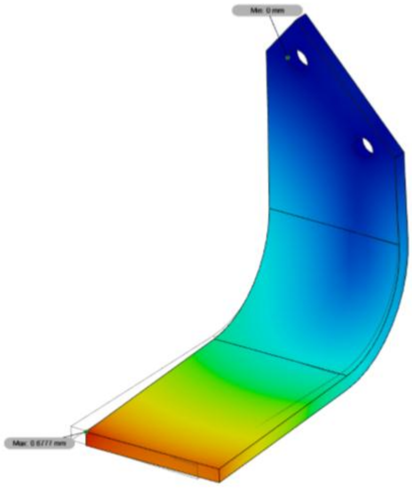

Fig.5 Deflection Analysis(mm)

	Radius 34		Radius 38	
Material	Black Soil	Black soil with clay	Black Soil	Black soil with clay
Mild Steel	0.5209	0.5552	0.6777	0.7223
EN8	0.5758	0.6136	0.7491	0.7983
EN24	0.5285	0.5632	0.6876	0.7328

Table1. Deflection Analysis result

B.Stress (MPa)

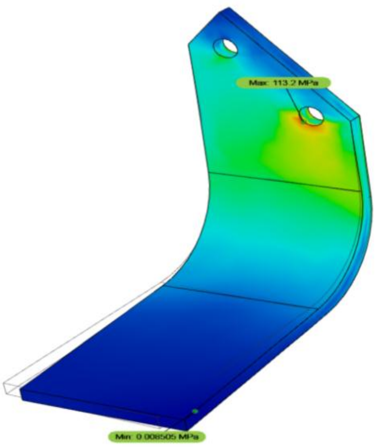

Fig.6 Stress Analysis(Mpa)

	Radius 34		Radius 38	
Material	Black Soil	Black soil with clay	Black Soil	Black soil with clay
Mild Steel	113.2	120.6	111.3	118.6
EN8	113.2	120.6	111.3	118.6
EN24	113.2	120.6	111.3	118.6

Table2. Stress Analysis result

C. Strain

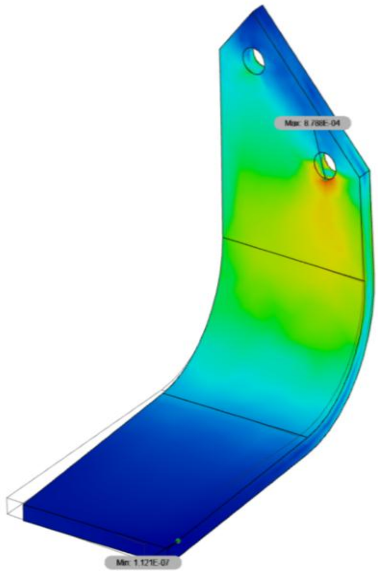

Fig.7 Strain Analysis

	Radius 34		Radius 38	
Materia l	Black Soil	Black soil with clay	Black Soil	Black soil with clay
Mild Steel	0.000878 4	0.000936 2	0.000878 8	0.000936 6
EN8	0.000970 9	0.001035 0	0.000971 3	0.001035 0
EN24	0.000891 2	0.000949 7	0.000891 5	0.000950 1

Table3. Strain Analysis result

6. CONCLUSIONS

- The problems on the blade were identified and solved. The standard material used for blade is mild steel and it is producing high stress.
- In this project, EN8 and EN24 steel materials and different blade dimensions are taken for analysis.
- The load condition is applied for existing and modified design blades.
- Deflection and strain characteristics are also accepted and provide accurate result compare to existing design.
- By this we can increase the working hours of the blades and by using different material we can increase the wear resistance of the blade.

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