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ANSYS ANALYSIS OF AGRICULTURE ROTAVATOR BLADE WITH VARYING BLADE MATERIALS

Payal R. Gupta[1], Sujit B. Karekar[2], Kiran M. Kamble[3] , Piyush S. Inglekar[4] , Ganesh K. Chaudhari[5] , Pankaj N. Shrirao[6]

[1,2,3,4,5,6]Mechanical Engineering Department, Jawaharlal Darda Institute of Engineering and Technology, Yavatmal, India

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***Abstract*: Nowadays, utilization of rotary tillers has been increased in agricultural applications because of simple structure and high efficiency for this type of tillage implements. Since blade is a crucial part in rotavator and it can manufactured or fabricated in different shapes like L, J and C. The life of blade is crucial factor and it depends on forces coming on blade and force and geometry of blade has direct relationship with each other. The intent of this paper is to carry out the structural analysis of rotavator blade with different blade materials under similar dimensions of blade and forces acting on blade. The proposed work deals with analyzing the stresses and deformation induced in L-shape geometry blade with varying blade materials such as High chromium steel (HCS), and H13 steel and results obtained are compared with the blade of standard mild steel material. For this reason a mathematical model is developed and blade analysis is carried out using ANSYS software applying Finite element analysis method on the basis of deflection and stresses induced in blade after application of force. The results obtained with material changed are compared with each other and it is found that less deflection and less stresses has induced in a blade with High chromium steel with radius of curvature R34.**

Keywords: *Blade Materials, ANSYS, Structural Analysis, Deformation Analysis.*

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I INTRODUCTION

Nowadays, utilization of rotary tillers has been increased in agricultural applications because of simple structure and high efficiency for this type of tillage implements. The geometry of tiller blades is considered to be the most important factor in their design since both the shape of the blade tip and the length of the tiller blade facilitate cutting (Jain-Song, 2007). Hence there is a need to improve the design through geometrical modifications so that will reduce the blade cost as well as land preparation cost.

Many researchers have developed a computer aided experimental system for design testing and valuation of agricultural tools and equipment. The selected physical model of rotavator have been measured with accurate dimensions and a solid (3-D) model have prepared in CAD-software such as ANSYS, CATIA, Pro/E, hyper mesh etc. by assembling an individual parts with detail specifications.

Subrata Kr. Mandal and Basudeb Bhattacharya [1] investigated design and development of rotavator blade through the interrogation of computer aided design (CAD) method. This paper describes the interaction of Blades 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.

Gopal U. Shinde and Shyam R. Kajale [2] explained 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 was done by using CAD-Analysis software for the structural analysis. The different tillage tool parts of rotary tillage tools were geometrically constrained by the preparation of solid model,

meshing and simulation was done with actual field performance rating parameters along with boundary conditions.

Rahul Davis [3] experimentally studied the cutting parameter optimization (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.

N.M.Zarroug, R.Padmanabhan, B.J.MacDonald, P.Young, M.S.J.Hashmi [4] obtained the results for 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 [5] in the study revealed 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.

This paper describes the design improvement and development of blade through computational methods.

RESEARCH OBJECTIVE

- To evaluate Stress induced in the blade with varying blade material.
- To find out Deformation in blade for varying blade material.
- To analyze Strain in blade with different blade material.

II METHODOLOGY

The proposed work deals with the analyzing rotavator blade in the ANSYS workbench with Existing mild steel material and new materials such as High chromium steel (HCS) and H13 steel. For analysis was carried out for the load exerted on blade by black soil as well by black soil with clay. The results obtained by considering both the loads with three varying blade materials are compared and graph is plotted.

Engineering analysis is concerned with analysis and evaluation of engineering product designs. For this purpose, a number of computer-based techniques are used to calculate the product's operational, functional, and manufacturing parameters. Finite element analysis (FEA) is one of the most frequently used engineering analysis techniques. Besides FEA, tolerance analysis, design optimization, mechanism analysis, and mass property analysis are some of the computer aided techniques available to engineers for the purposes of analysis and evaluation of the engineering product designs.

Basic steps involved in carrying out FEA are

- ✓ Pre-processing.
- ✓ Conversion of geometric model into finite element model.
- ✓ Assembly/Material Property data representation.
- ✓ Defining the boundary conditions.
- ✓ Loading Configuration.
- ✓ Processing.
- ✓ Post-processing.

III RESULTS AND DISCUSSIONS

Existing and new materials are analyzed in the ANSYS workbench and the results are compared and graph is plotted.

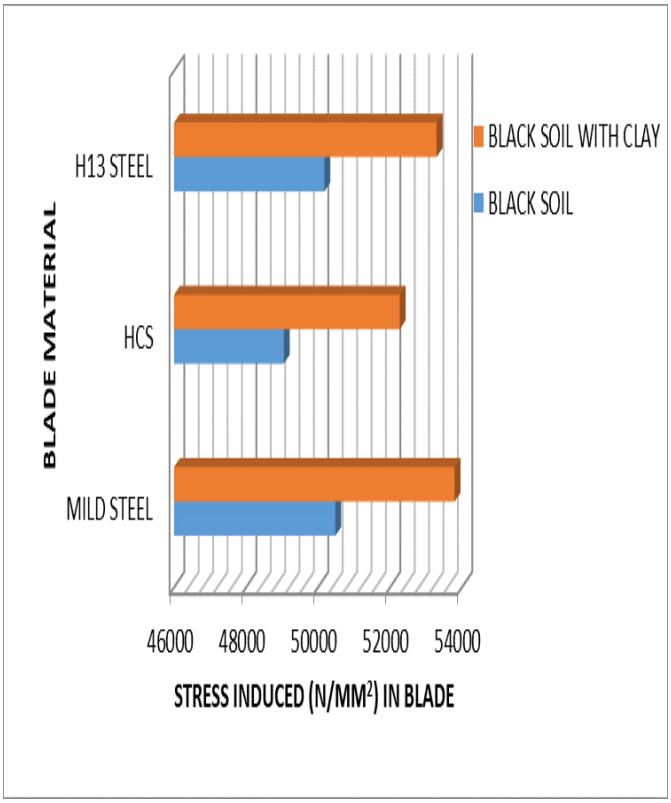

Fig. 1: Stress induced in blade Vs Blade materials

Fig. 1 indicates variation of Stress induced in blade with respect to Blade material. In the analysis of current L-shape blade design by considering the Load acting on the blade area because of black soil, the maximum stress induced in blade with HCS material is obtained as 49050 N/mm^2 and with mild steel material is observed as 50479 N/mm^2. And by considering the Load acting on the blade area by black soil with clay, the maximum stress in blade with HCS material is obtained as 52273 N/mm^2 and with mild steel material is

observed as 53796 N/mm^2. This is due to HCS material is having better mechanical properties compared to mild steel and H13 steel.

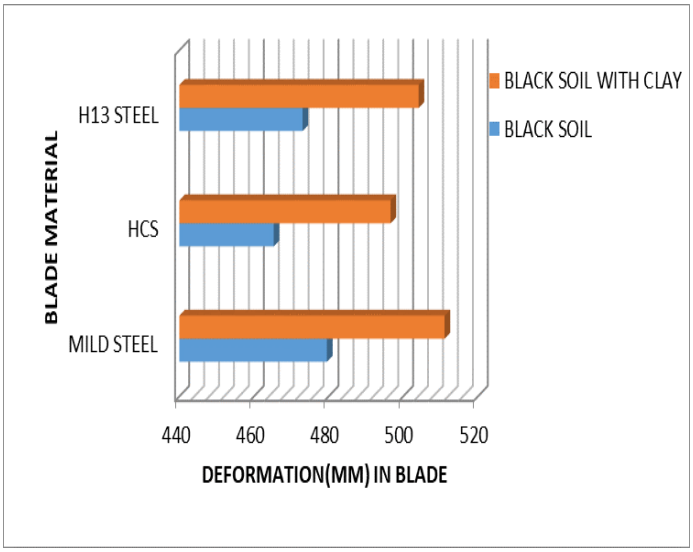

Fig. 2: Deformation in blade Vs Blade materials

Fig.2 depicts variation of deformation in blade with respect to Blade material. In the analysis of current L-shape blade design by considering the Load acting on the blade area because of black soil, the maximum deformation in blade with HCS material is obtained as 465.28 mm and with mild steel material is observed as 479.55 mm. And by considering the Load acting on the blade area by black soil with clay, the maximum deformation in blade with HCS material is obtained as 496.59 mm and with mild steel material is observed as 511.06 mm. This is due to HCS material is having better mechanical properties compared to mild steel and H13 steel.

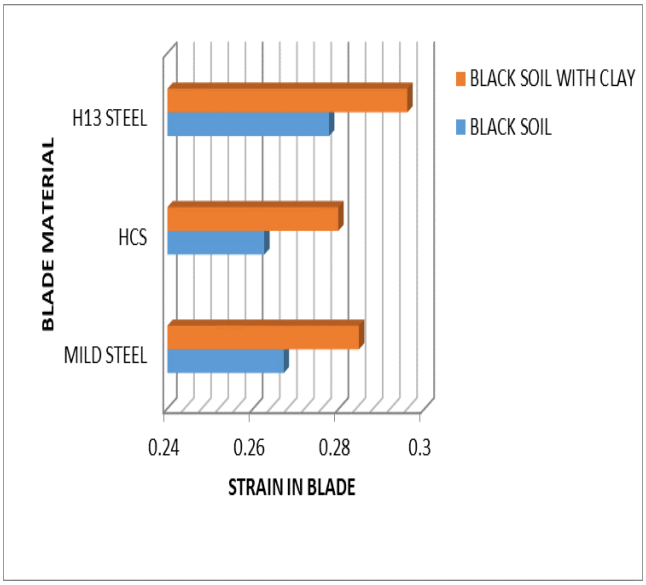

Fig. 3: Strain in blade Vs Blade materials

Fig.3 denotes variation of Strain in blade with respect to Blade materials. In the analysis of current L-shape blade design by considering the Load acting on the blade area due to black soil, the maximum strain in blade with HCS material is obtained as 0.26259 and with mild steel material is observed as 0.26712. And by considering the Load acting on the blade area by black soil with clay, the maximum strain in blade with HCS material is obtained as 0.27985 and with mild steel material is observed as 0.28467. This is due to HCS material is having better mechanical properties compared to mild steel and H13 steel.

IV CONCLUSION

The ANSYS analysis is done for L-shape geometry blade with varying blade materials such as High chromium steel (HCS), and H13 steel and results obtained are compared with the blade of standard mild steel material. It is observed that the blade with High chromium steel (HCS) produces less stress compared to Mild steel. Deformation and strain characteristics for blade with High chromium steel (HCS) are also acceptable and provide accurate result compared to existing material. By using different materials the wear resistance of the blades can be increased and hence increase the working hours of the blades.

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