International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

Use of Cad Tool for Design, Analysis and Development of Rotary Tillage Tool

Dr. Ashok G. Matani[1], Ankush D. Bhishnurkar[2]

[1]Associate Professor, Government College of Engineering, Amravati – 444 604 [M.S.] India,

[2]Final Year M.Tech. [Production Engineering],Government College of Engineering, Amravati – 444 604 [M.S.] India

Abstract: ***Tillage is an operation performed on the field to obtain a desirable soil structure for perfect seedbed preparation for sowing seeds. Rotavator or Rotary tiller is a tillage machine Manufactured for preparing land by breaking the soil with the help of rotating blades. The development of Rotavator blades is an on-going process. The Rotary Tiller's Blade is geometrically constrained with preparation of solid model in CAD-Software and the Analysis is done with actual field performance rating parameters by using CAD-Analysis software for the structural analysis. The energy constrained for the tillage tool operations with 37Hp and 45Hp power tractor and estimated forces acting at soil-tool interface. The resultant effect on Rotary Tiller's Blade is obtained from Von-Mises stress, maximum principal stress, tensile stress and shear stress distribution plots. The present working model with tillage blade is analysed to new design constraints with change of its geometry for the maximum weed removal efficiency is suggested for the lab and field testing.***

Keywords: Deformation, Rotavator, Rotary Tiller's Blade, Structural Analysis, Von Misses Stress.

1. Introduction

The development of Rotavator blades is an on-going process and new blades, particularly in the Asian subcontinent and Japan, where the Rotavator is widely used. The direction of rotation affects the manner because of its design in which soil failure occurs during the rotary tillage operation. Increase in fossil fuel prices leads to higher level of Agricultural land preparation cost which directly leads to increase in the cost of food. Farmers are more interested to improve cost to benefit ratio by reduce the land preparation cost and increase the yield. Now a day it is possible by using Rotary tiller or Rotavator for seedbed preparation. In a Rotavator Blades are the main parts which are engaged with soil to prepare the seedbed for sowing. Rotavator is a widely used machine for tillage operation in Indian farming because of its superior ability to mix, flatten and pulverize soil. This paper describes the design analysis of blade through computational method.

2. Objectives

1) To prepare a geometric solid model of Rotary Tiller's Blade by using CAD-software.
2) To generate a CAD analysis report of rotary tillage tool components.

3. Blade Details

The blade configuration influences the performance of Rotavator. Investigated the performance characteristics of three types of blades, *viz*, 'C', 'J' and 'L' shaped blades in terms of power requirements and the puddling quality of a tractor-driven Rotavator in a wet clay soil. L-shaped blades are mostly used in Rotary Tillers manufactured in Indian because of its effectiveness over 'C' type and 'J' type blades. These blades are normally mounted with three right handed and three left handed blades per flange.

Table 1: Blade Parameters

Sr.	*Parameters*	*Values*
1	Blade span (mm)	40
2	Effective Vertical length (mm)	231
3	Blade cutting width (mm)	135
4	Blade thickness (mm)	9

4. Methodology

From literature it is clear that a "L" type blade is most suitable for Indian farming conditions compared to 'C' and 'J' type Blade, a blade was designed in 3D CAD software on the basis of geometrical parameters of actual 'L' type blade, followed by analysis in ANSYS.

The steps performed in ANSYS for analysis are import design, meshing, input parameters and solution. The structural analysis was done based on field trial data available from the manufacturer and farmers.

$$Ks = Cs\frac{75Nc.\eta c.\eta z}{u} \quad (1)$$

Where-
Ks = maximum tangential force (kg),
Nc = Prime mover Tractor Power (HP),
ηc = Traction efficiency,
ηz = Coefficient of reservation of tractor power,
Cs = is the reliability factor that is equal to 1.5 for non-rocky soils and 2 for rocky soils,
u = Prime mover forward speed (m/s)

$$Ke = \frac{Ks.Cp}{i.Ze.Ne} \quad (2)$$

Where-
Ke = soil force acting perpendicularly on the cutting edges of each of the blades
Cp = coefficient of tangential force,
i = number of flanges,
Ze = number of blades on each side of the flanges,

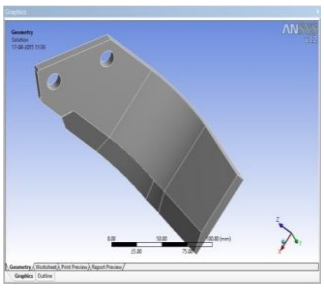
Ne = number of blades which action jointly on the soil.

Table 2: Input Parameters for the Analysis

Sr.	*Parameters*	*Values*
1	Rotary tiller work depth (mm)	220
2	Rotary tiller work width (mm)	1500
3	Rotor rpm	210
4	Blade peripheral velocity (m/s)	5
5	Total number of blade	36
6	Number of blades on each side of the flanges	6
7	Prime mover forward speed (m/s)	1.2
8	Number of blades which action jointly on the soil	6
9	Prime mover Power (HP)	37-45
10	Traction efficiency (η_t)	0.9

5. Results

The analysis results of left hand blade in graphical mode have shown in figures below. As in case of tillage tools, deformation is related to tool wear but stress plays a major role which results in wear of the tool [6]. In this analysis, because of variations in tool shape the stress variation is obtained. The resultant for deformations, Von-Mises stress, maximum principal stress, tensile stress and shear stress is shown in Figures 1-6 below are for LH Rotavator blade of 9mm thickness.



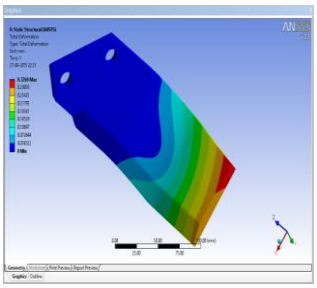
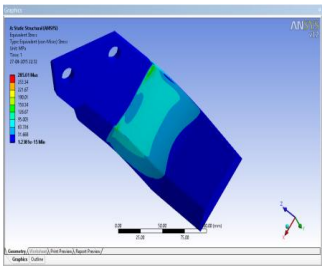


Figure 1: 3D-Model **Figure 2:** Deformations



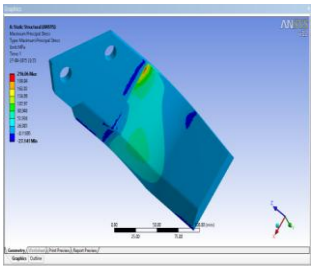
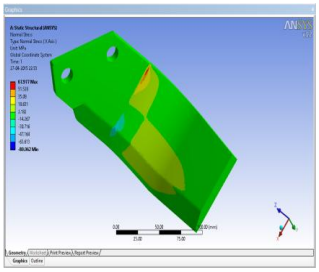


Figure 3: Von-Mises Stress **Figure 4:** Max. Principal Stress



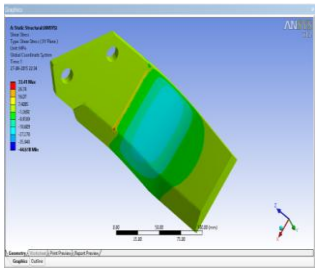


Figure 11: Tensile Stress **Figure 12:** Shear Stress

Table 3: Stresses in Blade

Sr.	Factor	Values
1	Maximum Deformations	0.33 mm
2	Maximum Von-Mises Stress	285 MPa
3	Maximum Principal Stress	216 MPa
4	Maximum Tensile Stress	68 MPa
5	Maximum Shear Stress	33.4 MPa

6. Conclusions

3D CAD model of tillage blade is analysed to new design constraints. This model is analysed for deformations, Von-Mises stress, maximum principal stress, tensile stress and shear stress. The results of structural analysis are evaluated for 45HP tractor. For effective performance of rotavator blade it is suggested for the lab and field testing.

References

[1] S.K. Mandal, Dr. B. Bhattacharya, Dr.S. Mukherjee, Optimization of Design Parameters for Rotary tiller's Blade, Proceedings of the 1st International and 16th National Conference on Machines and Mechanisms, IIT Roorkee, India, Dec 18-20 2013.

[2] G.U. Shinde, J.M. Potekar, R.V. Shinde, Dr. S.R. Kajale, Design Analysis of Rotary Tillage Tool Components by CAD-tool: Rotavator, International Conference on Environmental and Agriculture Engineering IPCBEE, Singapore vol.15, 2011.

[3] M. Sadiq, M. Jamil, S. M. Mehdi, G. Hassan and J. Akhtar, Effect of different tillage implements on wheat production in rice-wheat cropping system in saline sodic soil, Pakistan journal of Agronomy 1(2-3), pp. 98-100, 2002.

[4] Dr. A.G. Matani, 1999, Managing new product innovations, Industrial Engineering Journal, 4(1), pp. 21-23.

[5] Gopal U. Shinde and Shyam R. Kajale, Design Optimization in Rotary Tillage Tool System Components by Computer Aided Engineering Analysis, International Journal of Environmental Science and Development, 3(3), pp. 279-282, June 2012.

[6] Subrata K.R. Mandal, Basudeb Bhattacharyya, Somenath Mukherjee and P. Chattopadhyay, Use of Cad Tool for Design and Development of Rotavator Blade, Middle-East Journal of Scientific Research 20 (2), pp. 171-177, 2014.

[7] Dr. A.G. Matani, Automobile exhaust emissions in Indian Environment Programmes and strategies needed for controlling, Journal of Environmental Research and Development, 5(3), pp. 584 – 590, 2011.

[8] Dr. Ashok G. Matani S. K. Doifode, Effective Industrial Waste Utilization Technologies towards Cleaner Environment, International Journal of Chemical and Physical Sciences, 4(1), pp. 536-540, 2015.

[9] Amardeep Singh Kang, Jasmaninder Singh Grewal, Deepak Jain and Shivani Kang, Wear Behavior of Thermal Spray Coatings on Rotavator Blades, 21(2), pp 355-359, March 2012.

[10] Jain-Song Ju, Study on the Characteristics of Tiller Blade Shapes by Spray- Welding Hardening, Journal of Marine Science and Technology, 15(3), pp. 219-231, 2007.

[11] V. N. Ahuja Dr. A. G. Somvanshi, Dr. A. G. Matani, CSR of industries towards improving quality of

education, Journal of Teacher Education in Developing Nations, 1(1), pp.96-100, 2010.
[12] Subrata Kr. Mandal, Basudeb Bhattacharyya, Somenath Mukherjee, Priyabrata Chattopadhyay, Design & Development of Rotavator blade: Interrogation of CAD Method, International Journal of Scientific Research in Knowledge (IJSRK), 1(10), pp. 439-447, 2013.
[13] Dr. A. G. Matani, Common Effluent Treatment Plants: Prospects and Potentialities in Indian Manufacturing", Journal of Industrial Pollution Control, 15(3), pp. 113-116, 1999.
[14] M. Azadbakht, B. Azadbakht, R. Janzade Galogah, A. Kiapei, H. Jafari, Soil Properties after Plowing with Vertical and Horizontal Axis Rotavator, International Journal of Environmental, Ecological, Geological and Mining Engineering, 8 (1), pp. 61-65, 2014.

Author Profile

Dr. Ashok G. Matani is presently working as Associate Professor -Mechanical Engg Dept. Govt. College of Engineering, Amravati- [M.S.]- India. He is Ph.D. (Mechanical Engineering, MBA (Marketing), having total academic, research, administrative & industrial experience of more than 27 Years. His areas of interest are: Energy Conservation, Industrial Engineering, Productivity, Industrial Management, Operations Management, Entrepreneurship, Corporate Social Responsibility (CSR). He had presented an excellent number of research / technical papers Seminars / Conferences in Indian Institutes of Technology [IITs/ IIMs/ NITs]. Under his guidance, One Ph.D. scholar had been awarded Ph.D. degree & three Ph.D. scholars research work in progress. He had delivered keynote address in various international conference organized in India. He is Member of Editorial Board of Journals / Reviewer of Journals published for various countries. He is also life membership of various professional societies such as ORSI, IE(I) ISE, NAFEN, ISTE, IIIE .

Ankush D. Bhishnurkar has Completed Bachelor of Engineering in Automobile Engineering (2012) from North Maharashtra University, Jalgaon, India. M.Tech. final year student specialization in Production Engineering at Government College of Engineering Amravati, Maharashtra. My area of research is to improve effectiveness of Rotavator. It is an effort to help the farmers for rapid and effective seedbed preparation which will result to gain higher cost to benefits ratio.