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A Review on Rotavator Blade Study and its Life Improvement by Means of FEA Analysis

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Abstract:

Rotavator blade life improvement is the main objective of entire study. This part fails before its predefined designed life due to the heavy stresses acting on it. During working of rotavator, blade comes in contact with soil and rocks present inside the field. Sometimes rocks may impose lots of stresses on rotavator blade. In such critical conditions blade may fails and may impact on the entire rotavator working. Hence the health of rotavator blade is always supposed to be monitored.

This study is focused on the study of various reviews available on this topic. For this purpose the available studies are reviewed and studied well to know the exact reasons of failure of rotavator blades. The outcomes on this study are based on the literature survey done and exposure is given to the modern studies based on the FEA analysis and the tools which are most powerful now a days.

Keywords — **Rotavator Blade, Blade Life, FEA Analysis**

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I. INTRODUCTION

The rotavator is a tillage tool primarily comprising of L-shape blades mounted on flanges that are fixed to a shaft and it is driven by the tractor power-take-off (PTO) shaft. In comparison to passive tools, the rotavator has a superior soil mixing and pulverization capability. During rotavator tillage operations various factors affect its energy requirements. These factors can include soil conditions, operational conditions and rotavator configuration.

There are two types of blade configuration used in rotavator. The following blade configuration shows high grade of cultivation,

- Three blade configuration
- Two blade configuration

***A. Three Blade Configuration*:** This is the standard blades configuration and has a three pair of blades per flange except the end flanges which are fitted with one hand only.

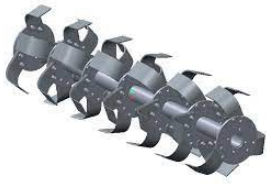

Fig. 1: Three Blade Rotavator Configuration

***B.Two Blade Configuration*:** The rotor may be converted into two blade configuration. Two blades per flange used in the rotavator except the end flanges. In this blade configuration, less tendency to the rotor to clog in sticky soil conditions. A cloddy finish can be obtained and rotor can be driven at faster rpm.

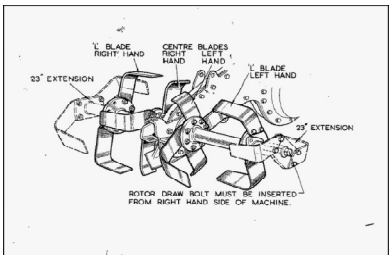

Fig. 2: Two Blade Rotavator Configuration

II. TYPE OF BLADES

Rotavator are usually supplied with „power" or L blades for general work. When working in heavy and puggy clay soils, the „speed" or „C" blades should be used.

- L blade
- C blade

A. 'L' blade: The long shank blade as the name implies, has longer shank than the standard power blade. This allows the greater clearance between the blade and rotor. With this, a greater depth of cultivation is obtainable if tractor power and conditions are allowed.

"L" blades are the original form of rotary blades that were used on the first Rotavator machines of their time. They were designed to fit a constant depth across the full width of tillage. The leading edges of the shank and foot where sharpened for easy penetration and the sole of the blade foot was curved inwards from front to rear so that as the blade cut into the soil; it was pulled forward by the motion of the tractor - only the cutting edge of the blade was in contact with the ground. This curvature of the foot and of the blade was, and still is, an important feature of all Howard blades. With no more than the cutting edge in contact with the soil beneath the blade, not only is there no downward pressure to compact the ground below, but the blade itself is self-sharpening. "L" blades are still the best choice for Shallow cultivations of 2" or less, or in base of the tillage zone needs to be leveled.

B. 'C' blade: This blade has more efficient self-cleaning action, uses less power and produces a coarser finish than the other blades. Other blades like trash, renovating to fit the special rotors for specific applications.

"C" blades are the next step in blade innovation. This is a blade which starts with a vertical shank and ends with a horizontal foot but in which the sharp right-angle bend between the shank and foot of the "L" blade is replaced by a gentler curve. The "C" blade takes less power to operate then the "L" and so is well suited to general tillage work carried out at depths greater than 2". The base of the zone tilled by the "C" blade is scalloped, which makes it less suitable for the shallow cultivation. Maximum depth of the tillage that can be achieved with the "C" blades is 1"-2" greater than the "L" blades and the higher power of the "L" blades will usually man that a machine fitted with them will have to be worked at a slower travel speed than one fitted with "C" blades, working in similar conditions at the same depth.

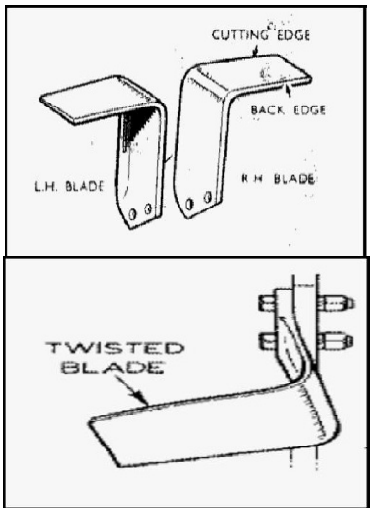

Fig. 3: Types of Blade

A. Page Layout

Your paper must use a page size corresponding to A4 which is 210mm (8.27") wide and 297mm (11.69") long. The margins must be set as follows:

- Top = 19mm (0.75")
- Bottom = 43mm (1.69")
- Left = Right = 14.32mm (0.56")

Your paper must be in two column format with a space of 4.22mm (0.17") between columns.

III. LITERATURE SURVEY

Gopal U.Shinde1, J.M.Potekar2, "Design Analysis of Rotary Tillage Tool Components by CAD-tool: Rotavator". The application of CAD/CAM in design optimization of rotary tillage tool on the basis of finite element method and simulation method is done by using CAD-software for the structural analysis. The different tillage tool parts of rotary tillage tools are geometrically constrained with preparation of solid model and The Simulation is done with actual field performance rating parameters along with boundary conditions. The energy constrained for the tillage tool applications with 35Hp and 45Hp power tractor and estimated forces acting at soil-tool interface. The resultant effect on tillage blade and whole rotavator assembly is obtained from stress distribution and deformations plots. Their work results in identifying sufficient tolerance in changing the dimensions of rotavator frame sections and side gear box for removing the excess weight in a solid section and also to raise the weight of blade for a reliable strength. The present working model with tillage blade is analysed to new design constraints with change of its geometry for the maximum weed removal efficiency by presenting its practical results from the field performance. [1]

Subrata Kr. Mandal1*, Dr. Basudeb Bhattacharyya2, "Rotary Tiller's Blade Design using Finite Element Analysis (FEA)". Blades are the main critical parts of a rotary tiller, which are engaged with soil to prepare the land. These blades interact with soil in a different way than normal plows which are subjected to impact and high friction which ultimately creates unbalancing and non uniform forces on the rotary tiller which results wearing of the blades as a whole. The continuous fluctuating impact of soil crust / clods / stone develops high stress areas on blade tip or blade critical edges. Therefore, it is necessary to optimize the design of blade so that these blades experience less stress. Their paper aims at design optimization of rotary tiller blades using modern tools like FEA.[2]

Subrata K.R. Mandal, Basudeb Bhattacharyya, "Use of CAD Tool for Design and Development of Rotavator Blade". Rotary tiller or rotavator is a tillage machine most suitable for seedbed preparation. In a Rotary tiller, Blades are the main critical parts which are engaged with soil to prepare the land. These blades interact with soil in a different way than normal plows which are subjected to impact and high friction that creates unbalancing and non uniform forces which results wearing of the blades as a whole. This actually decreases the service life of a blade. Therefore, it is necessary to design and develop suitable blade so that service life also enhanced. This paper presents design and development of rotavator blade through the use of computer aided design (CAD) tools/method. [3]

Srinivasan. K1, Viswanath R. P2, "Design and Optimisation of Blades for Rotavators". The aim of their study is to design and optimize the Rotavator Blade for better life and performance on field. Hence any improvement in the field performance of the same would in turn, augment the productivity in the agricultural sector. Design and modelling of the Rotavator's Rotor assembly has been completed. The dynamic analysis of rotavator blades during the tilling operation on soil is obtained using the FEA tool Abaqus.[4]

Prof. N.A.Ghanokar1 & Prof. S. P. Pawar2, "Computer Aided Design and Analysis of Rotary Tillage Tool Component For Failure". Their paper presents stress analysis of rotavator blade for different thickness and different materials. They have selected L-shaped blade for the study because L shape is usually superior to others in heavy trash. They are better for killing weeds. Rotavators work in the very difficult conditions, so they bear heavy dynamic loads. Therefore, proper design of these equipment is necessary to increase their working life time and reduce the farming costs. For the study we have selected A 15 HP Mahindra Yuvraj 215 tractor and Shaktiman SRT 2.5 mini rotavator. We calculated Forces acting on each blade for different

thickness as well as different materials. After modeling of blade, we applied boundary and loading conditions on the models. Finally, models were analysed with analysis software. Results of this research can help the designers of rotavator blade to make similar works in their designs and increase the working life of blade. [5]

Subrata Kr Mandal, "Optimization of Design Parameters for Rotary tiller's Blade". These blades interact with soil in a different way than normal plows which are subjected to impact and high friction which ultimately creates unbalancing and non uniform forces on the rotary tiller which results wearing of the blades as a whole. The continuous fluctuating impact of soil crust / clods / stone develops high stress areas on blade tip or blade critical edges. Therefore, it is necessary to optimize the design of blade so that these blades experience less stress thereby reduces the wear. Thus an "L" type blade for tractor drawn Rotary tiller or Rotavator was designed and developed. Computer Aided Design package for designing of the blade and ANSYS programming was used for the simulation and optimization of the blade. Based on the simulation results optimized design of blade through was suggested. [6]

Mr. Prasad D. Tupkari1, Dr. P. K. Sharma, "Computer Aided Design and Analysis of Rotavator Blade". The rotavator or rotary tiller is a tillage tool primarily comprising blades mounted on flanges, which are attached to a shaft that is driven by the tractor power-take-off (PTO) shaft through gears or chain drive. Nowadays, utilization of rotary tillers has been increased in agricultural applications because of simple structure and high efficiency for this type of tillage implements. By taking advantage of rotary tillers, the primary and secondary tillage applications could be conjugated in one stage. [7]

Prof. Shinde V.B.1, Mr. Malve R.N.2, "Design and Development of Rotavator Blade". This study is aimed at design and development of L-shape rotavator blade of alloy steel and plain carbon steel. The life of blade is crucial factor and it depends non forces coming on blade and force and geometry of blade has direct relationship with each other. For the increase in life span of blade forces coming on it should be reduced. For this reason a mathematical model is developed and analysis of new model and previous model is carried out using SolidWorks software applying Finite element analysis method on the basis of deflection and stresses induced in blade after application of force. This result is compared with each other and it is found that new model has less deflection and less stresses induce in a blade. [8]

D.Ramesh Kumar1 and P.Mohanraj2, "Design and Analysis of Rotavator Blades for its Enhanced Performance in Tractors". 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 geometrically constrained with preparation of solid model of blades and simulation has been done with actual field performance rating parameters along with boundary conditions. The proposed work results are identifying sufficient tolerance in changing the material such as EN 8 steel and EN 24 steel. The dimensions of rotavator blade sections and to rise the life cycle of the blades for a reliable strength. The present geometry working model with tillage blade is analysed to new design change constraints of its geometry for the maximum weed removal efficiency by presenting its analysis results from the field performance. [9]

Jeevarathinam.A, Velmurugan.C, "Design Modification and Analysis of Rotavator Blade". In a Rotary tillage machine, Blades are the critical parts which are engaged with soil to prepare the land and to mix the fertilizer. These blades interact with soil in a different way than normal plows which are subjected to impact that creates cyclic forces which result in fatigue failure of the blade. This actually decreases the service life of a blade. Therefore, it is necessary to design and develop a suitable blade. Their paper describes the design modification and development of rotavator blade through the (CAD) interrogation method by modifying the design and also by modifying the

material properties. Then better design will be compared by comparing the results. [10]

Rohan Nanabhau Pawar1, Dr.S.I.Kolhe2, "Design and Analysis of Rotavator Blade for its Enhanced Performance in Tractors". Their 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. [11]

Mr. Ravindra B. Kankal and Prof. K. R. Sontakke, "Design and Analysis of L Shape Rotavator Blade". Their proposed work results are identifying sufficient tolerance in changing the material such as EN 8 steel and EN 24 steel. The dimensions of rotavator blade sections and to rise the life cycle of the blades for a reliable strength. The present geometry working model with tillage blade is analysed to new design change constraints of its geometry for the maximum weed removal efficiency by presenting its analysis results from the field performance. [12]

Prof. R.V. Kakde1, "Review Paper on Analysis of Rotavator Blade". Rotary rotavator or tiller is one of the tilling machines most suitable for seedbed preparation. In a Rotary tillage machine, Blades are the critical parts which are engaged with soil to prepare the land and to mix the fertilizer. These blades interact with soil in a different way than normal plows which are subjected to impact that create cyclic forces which result in fatigue failure of the blade. This actually decreases the service life of a blade. Therefore, it is necessary to design and develop a suitable blade. Their paper describes the design modification and development of rotavator blade through the (CAD) interrogation method by modifying the design and also by modifying the material properties. Then better design will be compared by comparing the results. [13]

D.Ramesh Kumar1 and P.Mohanraj2, "Design and Analysis of Rotavator Blades for its Enhanced Performance in Tractors". 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 geometrically constrained with preparation of solid model of blades and simulation has been done with actual field performance rating parameters along with boundary conditions. Their work results are identifying sufficient tolerance in changing the material such as EN 8 steel and EN 24 steel. The dimensions of rotavator blade sections and to rise the life cycle of the blades for a reliable strength. [14]

G. M. Vegad, Dr. R. Yadav, R. G. Jakasania, "Structural Analysis of Hatchet Type Rotavator Blade in CAD Software". In their study finite element analysis of hatchet type blade of rotavator was carried out using Solidworks and ANSYS software. 3D model of blade was made using Solidworks software and static structural analysis of blade was carried out using ANSYS software. The material and dimensions of hatchet type blade was selected as per Indian Standard IS: 6690-1981. Results of simulation showed that maximum deformation was observed as 4.14 mm for hatchet type blade at the given boundary conditions while maximum equivalent (von-mises) stress was 654.25 MPa. Maximum principal stress and maximum shear stress was found as 656.26 MPa and 327.60 MPa respectively in hatchet type blade. The value of factor of safety was 1.05 and found to be very low and obviously this value decreases under unwanted loading conditions of field operation so blade doesn't satisfy the safety conditions. [15]

Dr. Ashok G. Matani1, Ankush D. Bhishnurkar2, "Use of Cad Tool for Design, Analysis and Development of Rotary Tillage Tool". 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. Their 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. [16]

IV. CONCLUSION

1) Rotavator blade life is poor due to the higher stress implementation.
2) Replacement of blade is more beneficial than the repair.
3) There is large scope for the rotavator blade design
4) Different materials with different rotavator blade geometries may give the better results.
5) Focus needed on the rotavator blade life improvement.

REFERENCES

[1] Gopal U.Shinde1, J.M.Potekar2, R.V.Shinde3, "Design Analysis of Rotary Tillage Tool Components by CAD-tool: Rotavator". 2011 International Conference on Environmental and Agriculture Engineering, IPCBEE vol.15(2011) © (2011) IACSIT Press, Singapore

[2] Subrata Kr. Mandal1*, Dr. Basudeb Bhattacharyya2, "Rotary Tiller's Blade Design using Finite Element Analysis (FEA)". International Journal of Modern Studies in Mechanical Engineering (IJMSME) Volume 1, Issue 1, June 2015, PP 19-26 www.arcjournals.org

[3] Subrata K.R. Mandal, Basudeb Bhattacharyya, Use of Cad Tool for Design and Development of Rotavator Blade". Middle-East Journal of Scientific Research 20 (2): 171-177, 2014, ISSN 1990-9233, © IDOSI Publications, 2014, DOI: 10.5829/idosi.mejsr.2014.20.02.11564

[4] Srinivasan. K1, Viswanath R. P2, "Design and Optimisation of Blades for Rotavators". International Journal of Innovative Research in Science, Engineering and Technology, An ISO 3297: 2007 Certified Organization, Volume 4, Special Issue 4, April 2015, National Conference on Trends in Automotive Parts Systems and Applications (TAPSA-2015), On 20th & 21st March

[5] Prof. N.A.Ghanokar1 & Prof. S. P. Pawar2, "Computer Aided Design and Analysis of Rotary Tillage Tool Component for Failure". Global Journal of Engineering Science And Researches, [NC-Rase 18] ISSN 2348 – 8034 DOI: 10.5281/zenodo.1494037 Impact Factor- 5.070

[6] Subrata Kr Mandal, Dr. Somenath Mukherjee, "Optimization of Design Parameters for Rotary tiller's Blade". Proceedings of the 1st International and 16th National Conference on Machines and Mechanisms (iNaCoMM2013), IIT Roorkee, India, Dec 18-20 2013

[7] Mr. Prasad D. Tupkari1, Dr. P. K. Sharma2, "Computer Aided Design and Analysis of Rotavator Blade". International Journal of Advanced Technology in Engineering and Science www.ijates.com, Volume No.02, Issue No. 05, May 2014 ISSN (online): 2348 – 7550

[8] Prof. Shinde V.B.1, Mr. Malve R.N.2, "DESIGN AND DEVELOPMENT OF ROTAVATOR BLADE". International Journal of Science, Technology & Management www.ijstm.com, Volume No.04, Issue No. 04, April 2015 ISSN (online): 2394-1537

[9] D.Ramesh Kumar1 and P.Mohanraj2, "Design and Analysis of Rotavator Blades for its Enhanced Performance in Tractors". Asian Journal of Applied Science and Technology (AJAST) Volume 1, Issue 1, Pages 160-185, February 2017

[10] Jeevarathinam.A, Velmurugan.C, "Design Modification and Analysis of Rotavator Blade". IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X PP 43-50 www.iosrjournals.org

[11] Rohan Nanabhau Pawar1, Dr.S.I.Kolhe2, "Design and Analysis of Rotavator Blade for its Enhanced Performance in Tractors". International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 07 Issue: 07 | July 2020 www.irjet.net p-ISSN: 2395-0072

[12] Mr. Ravindra B. Kankal and Prof. K. R. Sontakke, "Design and Analysis of L Shape Rotavator Blade". IJARSCT ISSN (Online) 2581-9429, ISSN (Print) 2581-XXXX, International Journal of Advanced Research in Science, Communication and Technology (IJARSCT), Volume 1, Issue 1, January 2020

[13] Prof. R.V. Kakde, "Review Paper on Analysis of Rotavator Blade". Vol-2 Issue-3 2016 IJARIIE-ISSN(O)-2395-4396, www.ijariie.com

[14] D.Ramesh Kumar1 and P.Mohanraj2, "Design and Analysis of Rotavator Blades for its Enhanced Performance in Tractors". Asian Journal of Applied Science and Technology (AJAST) Volume 1, Issue 1, Pages 160-185, February 2017

[15] G. M. Vegad, Dr. R. Yadav, "Structural Analysis of Hatchet Type Rotavator Blade in CAD Software". National Conference on Recent trends in Engineering, Management, Pharmacy, Architecture and Science, 'NCETEMPAS - 2016'

[16] Dr. Ashok G. Matani1, Ankush D. Bhishnurkar2, "Use of Cad Tool for Design, Analysis and Development of Rotary Tillage Tool". International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064 Index Copernicus Value (2013): 6.14 | Impact Factor (2013): 4.438

