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Modified Design and Development of Rotavator Blade by using CAD/CAE Approach

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Abstract- Rotavator implements are now projected as important tillage machinery for better seedbed preparation and easy agriculture.Compareing different machinery consider Rotary tiller or rotavator is a tillage machine most suitable for seedbed preparation. In a Rotary tiller or Rotavator , Blades are the important and main critical parts which are come in contact with soil to prepare the land. During Operation 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 result in blade life lost and blade wear. This actually decreases the service life of a blade. Therefore, it is necessary to design and develop blade in such a way that self life of blade is enhanced. 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. This paper presents design and development of rotavator blade through the interrogation of computer aided design (CAD) method.

Keywords: Rotary tillage tool, Rotavator, 3D CAD Model, GCI, SS, Modeling, analysis.

I. INTRODUCTION

Rotary tillage is a mechanical manipulation of soil for proper seedbed preparation in crop production.The main objective is to develop desirable structure for a seedbed, control weeds or remove unwanted crop plant, manage plant residue and minimize soil erosion. It offers an advantage of rapid and proper seedbed preparation in crop production and reduced draft compared to conventional tillage. It can saved 30-35 % of time and 20-25 % in the cost of operation as compared to tillage by cultivator and harrow.

During operation tillage tool or blades play an important role in preparing proper seedbed and also for power and draft, required for operation as rotavator perform well in suitable soil conditions but consume high amounts of energy. In operation, blades is subjected to continuous fluctuating impact of soil which develops high stress on blade tip or blade critical edges due to which wear of blades take place. From considering this some work has been done to improve the service life of a rotavator blade.

The way to improve the service life of blade is the improvement in blade geometry. Hence, there is a need to improve the design through geometrical modifications of blades which will reduce the blade cost.

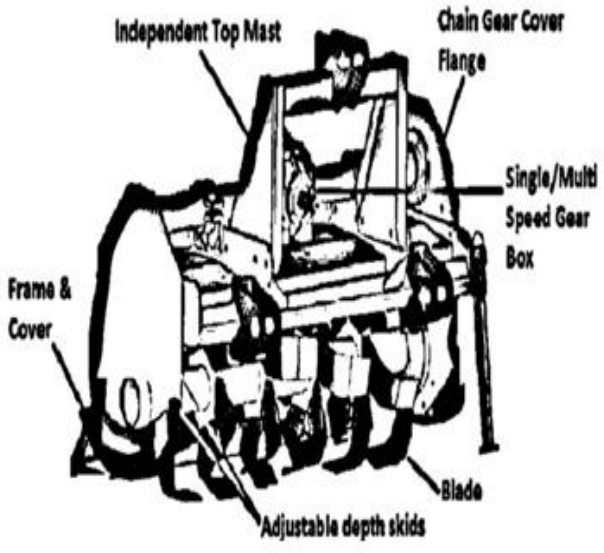

Fig 1. Rotavator.

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In Above Fig1 Shows Rotavator Machine Assembly with various components like

- Frame & Cover,
- Chain & Gear Cover Flange,
- Single/Multi speed Gear Box,
- Blades,
- Independent Top Mast,
- Adjustable depth skids.

1. Types of Rotavator Blade:

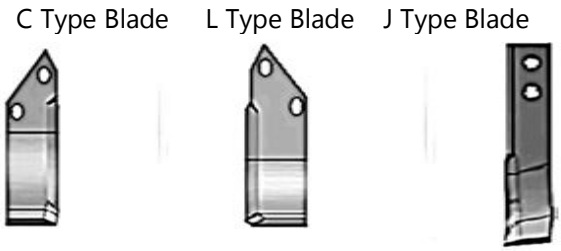

Fig 2. Various Types of Rotavator Blade.

In Figure 2 Shows some commanly used types of Rotavator Blades with simple cutting edge. There are various types of Rotavator Blades are used in Rotavator.

Like C Type Rotavator Blade, L Type Rotvator Blade, J Type Rotavator Blade, L & J Combination type of blade. The Most comanly used blade is C type Rotavator Blade.

II. METHODOLOGY

The Methodology used to Modified Design and Development of Rotavator Blade by using CAD. work started from Research introduction to rotavator blade including basic knowledge of rotavator, its function, construction and working. Various types of rotavator blade are studied and soil parameters, L-Type Rotavator Blade is selected for modification of saw type teeth is for analysis purpose.

Later on market survey is collected to identify the problems associated with rotavator blade.
The main problems are farm bed making in case of biger size soil breaking and removal of unwanted roots, and materials and the performance of Rotavaor and Rotavator Blades life. For this problem several literatures were studied and two materials are selected as Gray Cast Iron and Structural Steel.

1. 3D CAD Modeling:

Design new 3D CAD/ Model by using Creo with modifications of Saw cutting edge.

2. Analysis:

Then three geometry of rotavator blade selected as CP, for analysis purpose.

III. MODELING AND ANALYSIS

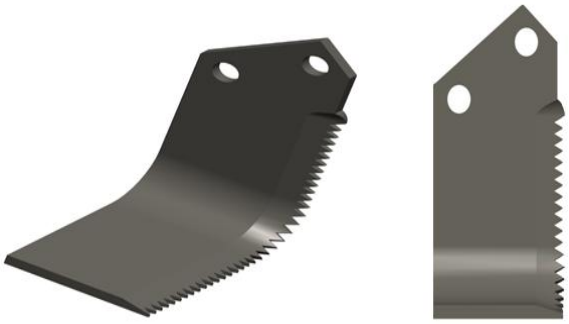

Fig 3. Modified Rotavator Blade with saw teeth.

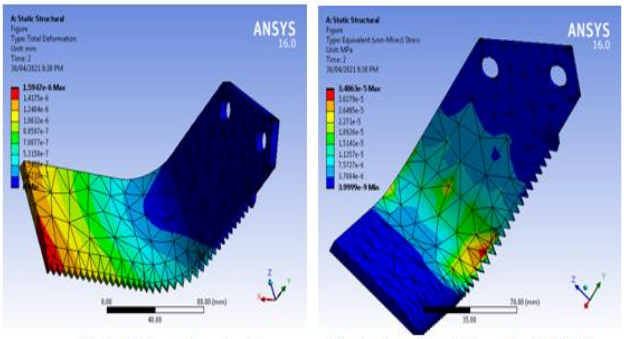

Fig 4. Analysis view Rotavator Blade with Load 600 N on Gray Cast Iron.

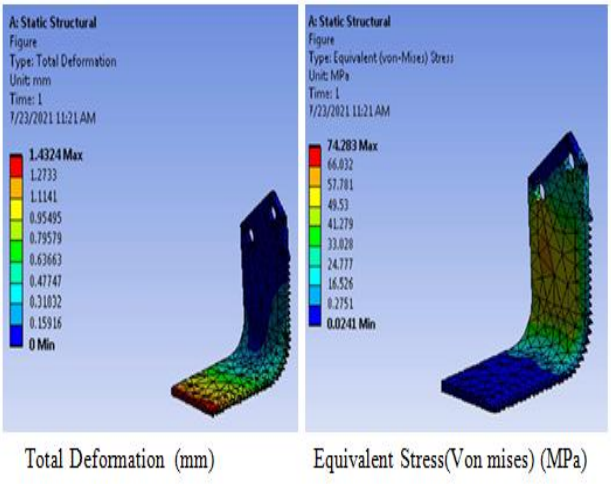

Fig 5. Analysis view Rotavator Blade with Load 1000 N on Gray Cast Iron.

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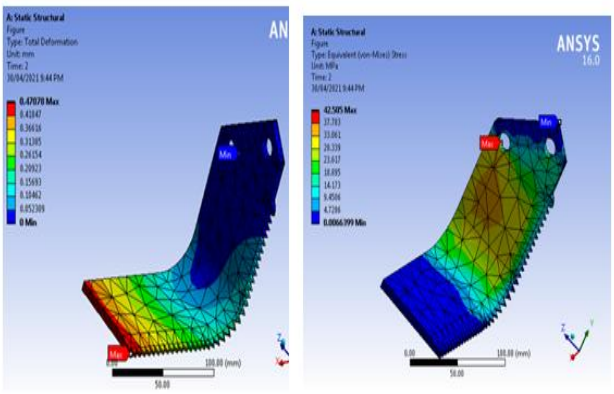

Fig 6. Analysis view Rotavator Blade with Load 600 N on Structural Steel.

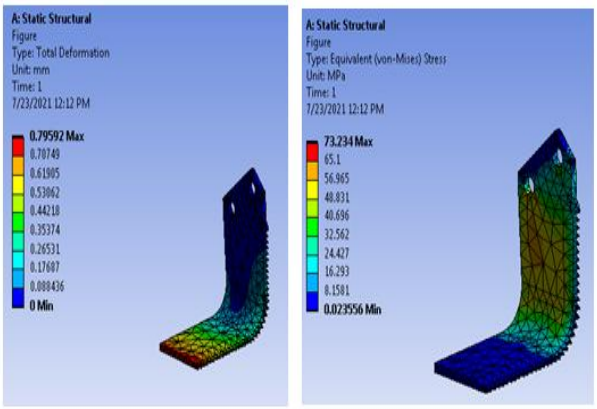

Fig 7. Analysis view Rotavator Blade with Load 1000N on Structural Steel.

IV. RESULTS AND DISCUSSION

When study the Rotavator blade at initial satge then found rotavator is one the important machine agriculture tool which is operated by tractor with the help of PTO to rotavator Gear box power transmitted and then it moves rotavator blade assembly in rotational direction.

And Rotavator Blade is one of the important part of Rotavator which directly contacted with the soil when making seed bed then we decided to modified the rotavator blade to perform more effective seed bed making by using saw teeth on cutting edge instead of simple cutting edge. We modified a Blade With Saw teeth its an a main aim of this research to develop & modified Design of Rotavator Blade.

In Analysis report when compared two different materials in Ansys software it is cleared that, the Total Load Vs Total Deformation of Gray Cast Iron in FEA report is more as compare to Structural Steel.

In Ansys Software to get Results with Different loading Conditions we Consider load 600N, 700N, 800N, 900N & 1000N as maximum load. In Graph 1 shows the Load v/s Total Deformation for two different material that is Gray Cast Iron & Structural Steel.Table 1 shows Results for the same.

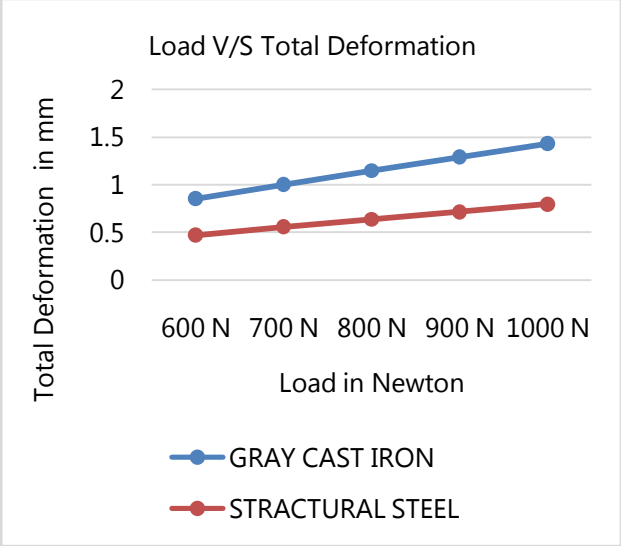

Fig 8. Graph 1: Load v/s Total Deformation Results Graph Comparison between Structural Steel & Gray Cast Iron.

Table 1. Load v/s Total Deformation Results Graph Comparison between Structural Steel & Gray Cast Iron.

Load V/S Total Deformation In (Mpa)					
Material	Load				
	600 N	700 N	800 N	900 N	1000 N
Gray Cast Iron	0.85231	1.0027	1.1459	1.2892	1.4324
Structural Steel	0.47078	0.55715	0.63674	0.71633	0.79592

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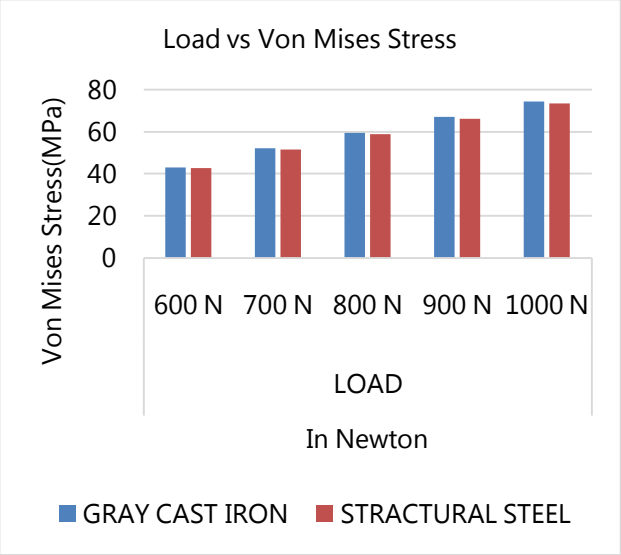

Fig 9. Graph 2: Load v/Equivalent Stress (Von Mises Stress) Results Comparison between Structural Steel & Gray.

Table 2. Von Mises Stress (Mpa).

VON MISES STRESS (Mpa)					
MATERIAL	LOAD				
	600 N	700 N	800 N	900 N	1000 N
GRAY CAST IRON	42.832	51.998	59.426	66.855	74.283
STRACTURAL STEEL	42.505	51.264	58.587	65.911	73.234

When Compare two Material with Maximum Permissible Stress of Gray Cast Iron & Structural Steel Analysis Results with different Load on Rotavator Blade due different conditions of soil, the results are as follows. Permissible Stress of Gray Cast Iron is 105 MPa.

Permissible Stress of Structural Steel is 140 MPa.

- When we consider min. load is 600 N on Gray Cast Iron then found max. Stress on body is **42.832 MPa** & When applied maximum load 1000 N on body then maximum stress produced is **74.283 Mpa.** Both results are within the limit of Permissible stress of 105 MPa hence Design is Safe.
- When we consider min. load is 600 N on Structural Steel then found max. stress on body is **42.505MPa** & When applied maximum load 1000 N on body then maximum stress produced is **73.234 Mpa.** Both results are within the limit of Permissible stress of 140 MPa hence Design is Safe.
- In the same way we check result on Ansys with Different Material GCI , SS & Load 700N, 800N, 900N to check in various loading conditions, results as shown in Table 2 and all is under Permissible Limit.
- Total Deformation when maximum load applied 1000N for Gray Cast Iron is **1.4324 mm &** for Structural Steel is **0.79592 mm.**

V. CONCLUSION

The work presented here is the Modified design and development of Rotavator Blade by using CAD/CAE Approach. The major Modification in this Blade is to make with Saw teeth in L-Type Rotavator blade instead of existing type rotavator blade simple Cutting edge to making a good bed cultivation by using Rotavator.

There are two materials (Gray Cast Iron & Structural Steel) are taken for study and the geometry CP are taken to understand the static behavior of Rotavator Blade when loaded by 600 N , 700 N, 800 N, 900 N, 1000 N load. Therefore, it draws the following conclusions:

It is concluded that one of the main part of Rotavator is the Blade and its direct contact with the soil land when it's rotating, blade is the main part for bed making. Hence, design of Blade is more important.
It is concluded that, the L-Type Modified blade with saw teeth is safe in FEA Results. It is concluded that, the FEA method gives practical results to make a Blade.

On the base of Total Deformation, it is concluded that the Gray Cast Iron is higher deformation than Structural Steel. It is concluded that in Gray Cast Iron maximum Stress Produced higher than Structural Steel.

It is concluded that, variation in geometry effects on the deformation and stiffness of Rotavatar Blade.
The Gray Cast Iron Material is Cost Effective as compared Structural Steel. Structural Steel is Efficient material than Gray Cast Iron.The Gray Cast Iron & Structural Steel Both material in various load conditions that is 600N, 700N, 800N, 900N, 1000N Maximum Stress is within Permissible limit.

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