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Design And Development Of Offset Furrow Disc Opener

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Abstract - *Sustainable improvement in the livelihoods of poor farmers in developing countries depends largely on the adoption of improved, resource-conserving cropping systems. In India the shovel type furrow opener is widely used. Furrow opener is a part of planter for opening a furrow and assists in placing of seeds. But these type of furrow openers demands a need to change its design due to its following limitations like shovel type furrow opener does not give a constant sowing depth, it does not have any provision to cover the seed in the furrow. Shovel type furrow opener produce greater soil disturbance. Therefore to make the necessary modifications available the project of double disk furrow opener has been undertaken. The main objective of this project is to inculcate new trends in field of agriculture and to reduce the human efforts and simultaneously increase the yield. The design and fabrication of the opener will include modifications of discs which will maintain uniform furrow depth and* cause *minimum disturbance of soil.*

Key Words: Disc opener, uniform depth, draft force, germination.

1. INTRODUCTION

India is a land of agriculture. There are varieties of techniques available for farming which include old as well as modern. The main objective of the equipments which are used in modern agriculture should be reducing human efforts and increasing the yield. Various operations which are performed on the agricultural land include ploughing, harvesting, sowing seeds, adding fertilizers. As now India too is been exposed to various modern techniques one of the widely used equipment to sow the seeds in soil is shovel type furrow opener.

Here the basic function of furrow opener is to make provisions to place the seed in soil. The furrow is created in the soil which assists the seed to placed in appropriate place. Though it's the basic and simple technique there are various disadvantages of it. Some of the major disadvantages are –

- This type of opener is unable to maintain constant soil depth.
- The soil disturbances created are more which ultimately affects the yield.
- There is no provision for covering the seed with soil after it is sowed.

Due to these limitations modification in the shovel type furrow opener is required. The project undertaken is double disk furrow opener. The main purpose of this project is to provide modern and simple technique to Indian farmers and to reduce the human efforts. The basic difference between these two is that the seed is covered with soil after it is sowed at certain depth by double disk furrow opener.

1.1. DISC FURROW OPENER

Disc coulters have different parameters that will affect their performance and also their interaction with soil. Disc diameter, disc thickness, edge angle, disc angle, tilt angle and also depth of the cut are the parameters that can change the forces acting on the disc when cutting through the soil. Edge angle is the slope of the edge of the disc that defines its sharpness. Although it seems to be a negligible parameter among other parameters of the soil, it plays an important role in residue cutting ability of the disc. Also it can change the draft force required to pull the disc. Disc angle is the angle of rotation of the disc around vertical axis. It is the angle that horizontal axis of the disc makes with the direction of motion. And the tilt angle is the angle of the disc with the vertical plane, or the angle created by rotation of the disc around disc's horizontal axis. Having a disc angle of greater than zero, in a planter that uses disc coulter, is inevitable. Because the disc should open a furrow, wide enough that a seed can fit. But the tilt angle is optional. We call it a compound angle when a disc coulter is orientated using both disc and tilt angles. The effect of these angles and their combination had to be studied, to find the best combination that result in minimum draft force (the horizontal reaction force to the disc motion). Starting with the soil engagement tool, double discs with compound angle and installed at a staggered position.

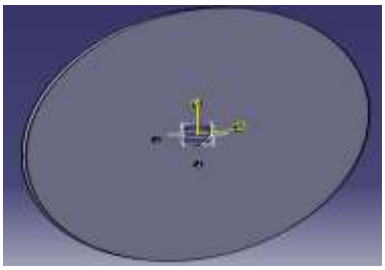

Fig1: Catia Model of a furrow disc

1.2. STATIC ANALYSIS OF DISC

Disc furrow opener is one of the important part which continuously run in a soil. The material used for this disc is mild steel. The disc is mounted on the shaft with a bearing housing. The disc is having a total 5 holes. One hole is provided at the centre where as other four holes are provided at pitch circle diameter in order to fasten bearing housing and furrow opening disc by means of nut and bolts. The disc is having diameter of 304 mm with a thickness of 3 mm. Thus at the point where holes are provided there are chances of stress concentration and breaking. Thus analysis of this component for static as well as dynamic condition is necessary.

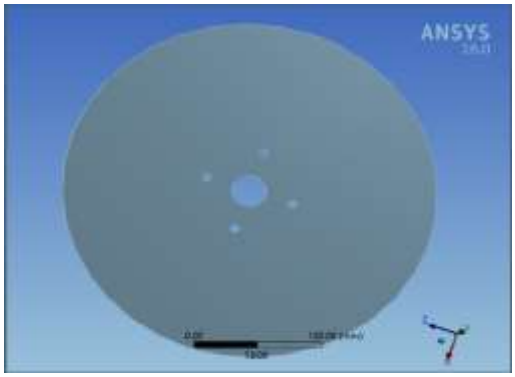

Fig2: Ansys model of furrow disc opener

Fig. 3 shows the meshing of disc. The meshing is done in a tetrahedral with 1173530 nodes and 233979 elements. Meshing is important to achieve better accuracy and fine results so tetrahedral meshing is selected.

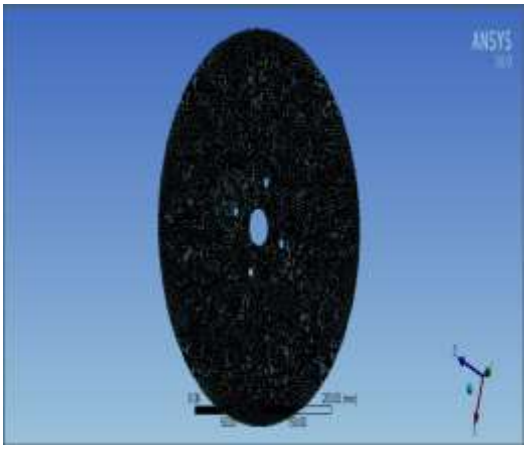

Fig3: Meshing of Disc furrow opener

External loads and boundary conditions are applied to the furrow opener disc as shown in table below

Object Name	Fixed Support	Force	Moment
State	Fully Defined		
Scope			
Scoping Method	Geometry Selection		
Geometry	8 Faces	1 Face	2 Faces
Definition			
Type	Fixed Support	Force	Moment
Suppressed	No		
Define By		Components	
Coordinate System		Global Coordinate System	
X Component		0. N (ramped)	0. N·mm (ramped)
Y Component		0. N (ramped)	-30000 N·mm (ramped)
Z Component		15001 N (ramped)	0. N·mm (ramped)
Behavior			Deformable
Advanced			
Pinball Region			All

Table.1: Loads

Fig. 4 shows the boundary condition applied at four fixed points. These four holes are provided on pitch circle diameter in order to fasten it with bearing housing and centre hole is provided for shaft of bearing. Thus these four holes are fixed and boundary condition is applied for same.

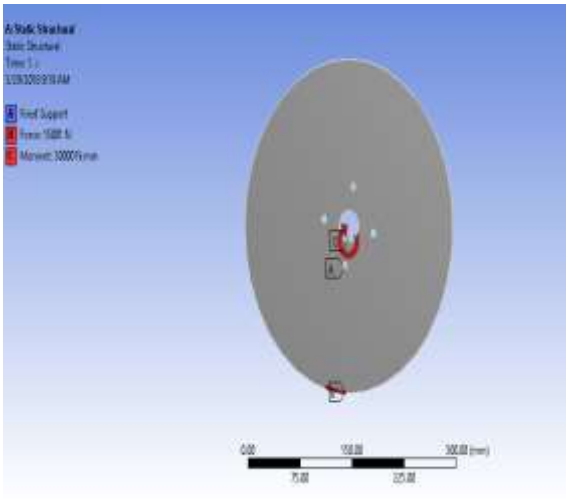

Fig4: Boundary Condition

Fig.5 shows the total deformation when the load is applied as 15001 N. It is observed that the maximum deformation is found at the edges of disc and the minimum deformation found on centre hole i.e. in between pitch circle diameter holes and centre hole. Thus it is seen that near the area where holes are provided the deformation is minimum. Following table.2 shows minimum and maximum total deformation of furrow disc opener.

Time[s]	Minimum[mm]	Maximum[mm]
1.	0	0.02208

Table.2: Total Deformation

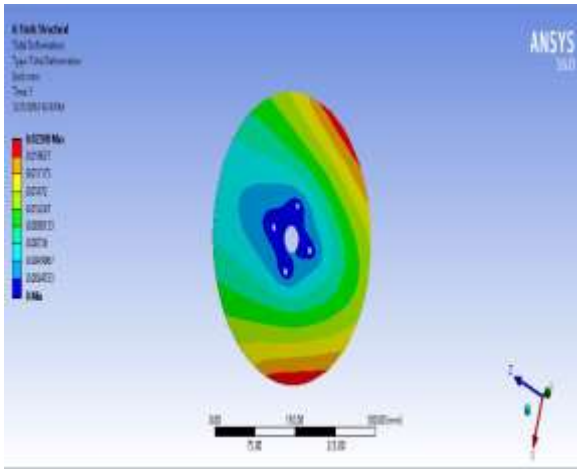

Fig5: Total deformation

Fig. 6 shows the Von Mises stress on a disc furrow opener disc. It is found that maximum stress is occurs at the holes on a pitch circle diameter and it is minimum at the edges of disc. Following table.3 shows maximum and minimum Von-Mises Stress of furrow disc opener.

Time[s]	Minimum[MPa]	Maximum[MPa]
1.	0.076733	155.22

Table.3: Von-Mises Stress

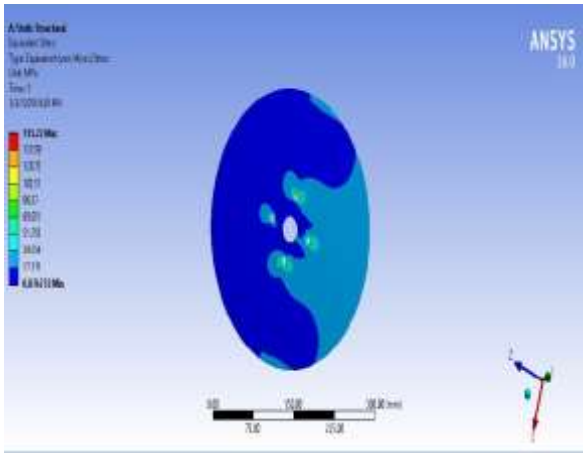

Fig6: Von-Mises Stress

The maximum principal stress is calculated as shown in fig.7. The maximum principal stress is found on the pitch circle diameter holes. However it is moderate where the portion of disc is in the soil i.e. 50 % area of disc which is in soil have moderate principal stress values and other portion having minimum principal stress values. Following table.4 shows maximum and minimum principal stress of furrow disc opener.

Time[s]	Minimum[MPa]	Maximum[MPa]
1.	-27.498	107.63

Table.4: Principal Stress

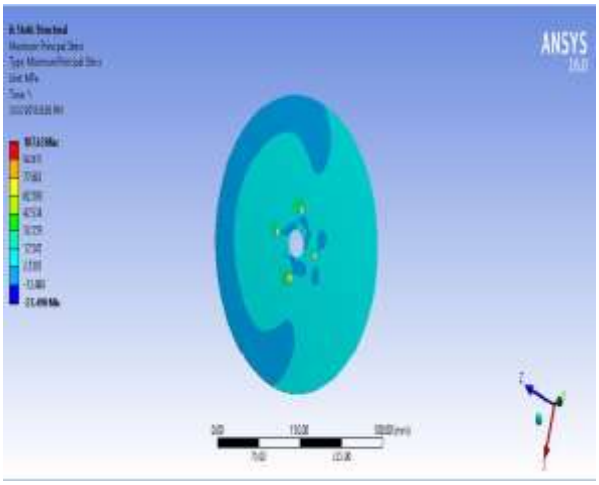

Fig7: Maximum Principal Stress

2. CONCLUSION

In this project we design the OPENERs, the conclusion of design of some parts are as follows,

- Uniform seed depth is obtain.
- All three operation furrow opening, furrow closing and pressing has been carried out simultaneously.
- Diameter of furrow opener disc is directly proportional to the width of furrow.
- The tilt angle of disc is directly proportional to the draft force required for tractor.
- Draft force required is reduced compared to conventional type of tine.
- Power required is reduced as compared to conventional type of tine.
- High speed sowing of seed is possible with this technology.

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