MODIFICATION AND DESIGN OF CULTIVATOR BLADE FOR MINIMUM LOAD

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ABSTRACT: *Weed control is a biggest problem in agriculture field. Weeds are plants growing where it is not necessary. They cause many disadvantages to the soil. So to remove weeds cultivator is invented. Cultivator is a mechanical machine which is used in various farms to remove weed. Cultivator blade with motor is used to remove weed easily. Blades are designed such as it cause less harm to plants and quick work with less labour required. Blades are inclined around 900. 150, 300, 450 angles are selected to design blades with thickness of 2mm, 3mm, 4mm. Force is consider as 0.35N⁄(mm^2) theoretical calculations are done. Design 3-D using solid edge software and convert that to Parasolid then with help of solid works parasolid is diagnosed and convert it to igs format for further analysis.*

Analysis is done to check whether the design is safe or not. On the designed model analysis is done for 2mm, 3mm, 4mm at 150, 300, 450 angles. Compare experimental results to theoretical results stress at 4mm 300 is less so the design is safe.

Keywords:Stress,Von-Mises,EN24,FEA,ANSYS,CATIA, SOLIDWOIRKS

1. INTRODUCTION

1.1. Weed Control

There are many definitions for weed control Plants that grow where it is unnecessary. A plant that requires some sort of action to reduce the impact on the economy, the environment and human health and comfort Known as Invasive plants.

Weeds are those plants which are not wanted, whose qualities are harmful to good points. Weeds are strong competitors naturally. In the process of handling certain weeds controlled, while other series.

2. METHODOLOGY

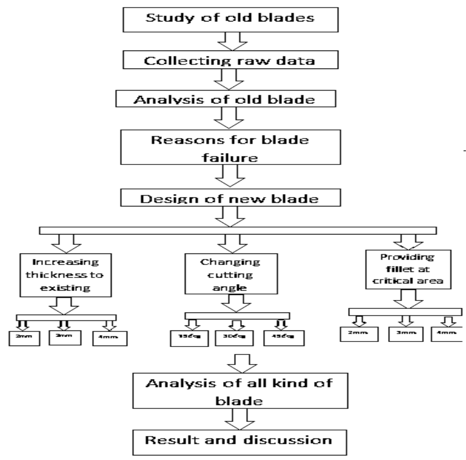


Fig (2.1) Methodology

3. COMPOSITION

From the reference EN-24 forged steel material is selected.

Sl .no	Composition alloy	Range%
1	Carbon	0.36-0.44
2	Silicon	0.10-0.35
3	Manganese	.045-.070
4	Nickel	1.30-1.70
5	Chromium	1.00-1.40
6	Molybdenum	0.20-0.35
7	Sulphur	.035max
8	Phosphorus	.040max

Fig (3.1) composition

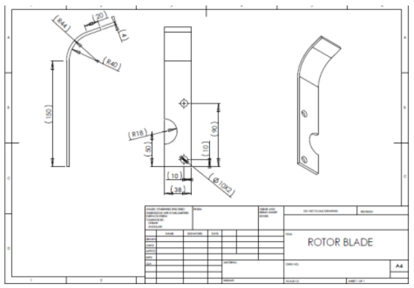
Sl no.	Properties	Unit
1	Tensile strength	850-1000 MPa
2	Yield stress	650 MPa
3	Impact	
(a)	Izod	30 Ft.lb
(b)	Charpy	35 J
4	Hardness	248-302 HB
5	Limiting ruling section	250mm

Mechanical properties of EN-24 material Fig (3.2)

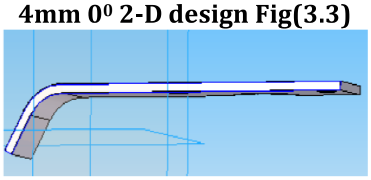
3.1. Blade Dimensions

Blade is a rectangular in shape. Of 200*38*4 mm at a distance of 150mm. Semi-circular hole is cut, which does not disturb the shaft and 10mm hole dia for mounting the bolts. Blades are arranged such that cutting is done progressively one blade after another is arranged.

3.2. CAD model



4mm 0^0 2-D design Fig(3.3)



4mm 0^0 3-D design Fig(3.4)

4. CALCULATIONS

Calculation of stress induced on cultivator on blade:-

$\boldsymbol{\theta}$ is cutting blade face twisting angle, so it is assumed for three values(15^0, 30^0, 45^0) for each angle stress induced is calculated for thickness(2mm, 3mm, 4mm).

For 3mm calculations:-

Pressure= 350KPa= 0.35N/mm^2

Area= width*length

Width= 4mm

Length= 4mm

Area= $1.6\times10^{-4}mm^2$

Pressure= Force/Area=

Force= Pressure*Area= 56N

Substitute θ and F in the above process.

Axial load, $\sigma_{b1}= \frac{F\times cos\theta\times(distance\ \ to\ central\ axis\ of\ first\ bolt)}{Z}$ N/mm^2

Perpendicular load, $\sigma_{b2}= \frac{F\times sin\theta\times(distance\ \ to\ central\ axis\ of\ \ first\ bolt)}{Z}$ N/mm^2

Total bending stress acting on the blade is

$\sigma_b = \sigma_{b1} + \sigma_{b2}$

Torsional shear stress:-

$\tau = \frac{F\times sin\theta\times R}{J}$

Put the value σ_b, τ maximum principal stress theory equation

$\sigma_1 = \frac{\sigma_b}{2} + \sqrt{((\frac{\sigma_b}{2})^2 + \tau^2)}\ \ N/mm^2$

4mm, 0^0:-

$\sigma_{b1} = \frac{56\times cos0\times80}{\frac{(4\times40\times40)}{6}} = 4.2N/mm^2$

$\sigma_{b2} = \frac{56\times sin0\times80}{\frac{(4\times3\times40)}{6}} = 0N/mm^2$

$\sigma_b = 4.2\ N/mm^2$

$\tau = \frac{56\times sin0\times20}{\frac{4\times40\times40\times40}{6}} = 0\ N/mm^2$

$\sigma_1 = \frac{4.2}{2} + \sqrt{((\frac{4.2}{2})^2 + 0} = 4.2$ N/(mm^2)

Similarly:-

Table (4.1) 4mm values

Thickness	Angle	Stress values in N/mm^2
4mm	0^0	4.2
	15^0	14.92
	30^0	16.34
	45^0	24.34

5. ANALYSIS

5.1. Finite element analysis

Steps involved in analysis

- Structure is divided in small elements. So that each element can be defined by differential equation. These differential equations converted into algebraic then to matrix form. Equational elements are converted into global structure.
- Proper loading and boundary conditions are applied and are incorporated into structural matrix. Structural matrix is solved and deflections at nodes are calculated.
- Single node can be shared by many elements and also deflection sharing between the elements at the node location. Deflection at the element can be calculated by interpolation of all the node points in the element. Element can have a linear or higher order interpolation function.
- Matrix equation combined into structure equatio

{F} = [K] {u}

5.2. Meshing:- Finite element analysis is the process of dividing or discretizing our geometry in finite nodes and elements and problems of stress and tensions and particular discretization process is known as meshing.

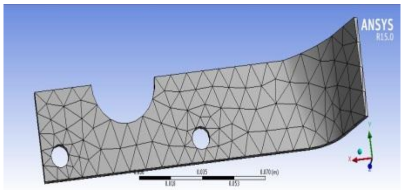


Fig (5.1) meshing

5.3. Loading and boundary condition

Boundary condition is based on the configuration, which is based on the plate. 2-holes and 1-semi circle are constraint in all degree of freedom.

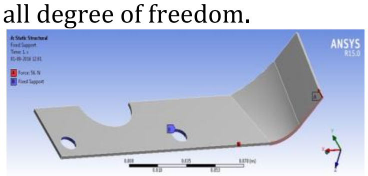


Fig (5.2) Loading and boundry condition

6. RESULT AND DISCUSSION

Table (6.1) 2mm, 3mm and 4mm stress values

Theoretical and Experimental comparison of stress, Fig (4.1)

THICKNESS	ANGLE	STRESS (FEA) (N/mm^2)
2mm	0^0	1877
	15^0	962.9
	30^0	405.08
	45^0	604.65
3mm	0^0	1059
	15^0	872.9
	30^0	296.05
	45^0	425.44
4mm	0^0	768.64
	15^0	10.15
	30^0	6.447
	45^0	7.447

6.1. Modelling

Fig (6.1) 4mm 15^0, 30^0, 45^0

Fig (6.2) 3mm 15^0, 30^0, 45^0

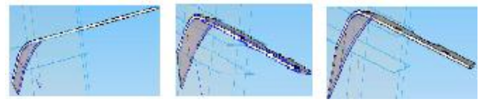
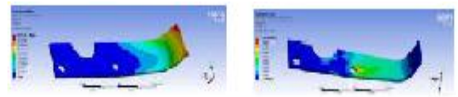


Fig (6.3) 2mm 15^0, 30^0, 45^0

6.2. Figures of analysis

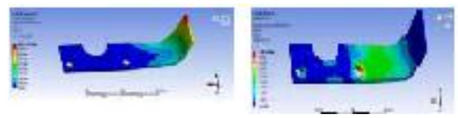
4mm 0^0



Total deformation Fig(4.10) Von-Mises stress Fig(4.11)

Deformation is 0.154×10^{-4}mm and Von-Mises stress is $768.64N/mm^2$

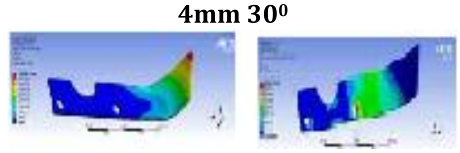
4mm 15^0



Total deformation Fig(4.12) Von-Mises stress Fig(4.13)

Deformation is 0.176×10^{-4}mm and Von-Mises stress is $10.15N/mm^2$

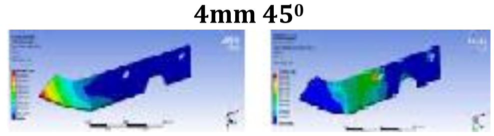
4mm 30^0



Total deformation Fig(4.14) Von-Mises stress Fig(4.15)

Deformation is 0.196×10^{-4}mm and Von-Mises stress is $6.799N/mm^2$

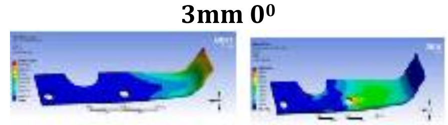
4mm 45^0



Total deformation Fig(4,16)
Von-Mises stress Fig(4.17)

Deformation is 0.184×10^{-4}mm and Von-Mises stress is $7.447\ N/mm^2$

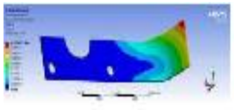
3mm 0^0



Total deformation Fig(4.18) Von-Mises stress Fig(4.19)

Deformation is 0.264×10^{-4}mm and Von-Mises stress is $1059N/mm^2$

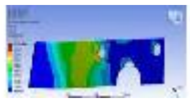
3mm 15^0

Total deformation Fig(4.20) Von-Mises stress Fig(4.21)

Deformation is 0.253×10^{-4}mm and Von-Mises stress is$872.9N/mm^2$

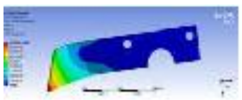
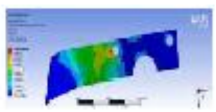
3mm 30^0

Total deformation Fig(4.22) Von-Mises stress Fig(4.23)

Deformation is 0.286×10^{-4}mm and Von-Mises stress is $296.05N/mm^2$

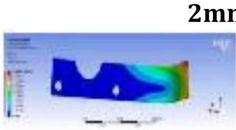
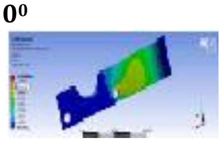
3mm 45^0

Total deformation Fig(4.24) Von-Mises stress Fig(4.25)

Deformation is 0.245×10^{-4}mm and Von-Mises stress is $425.44N/mm^2$

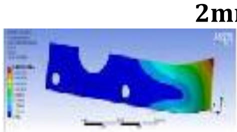
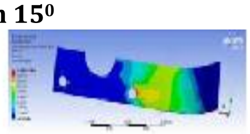
2mm 0^0

Total deformation Fig(4.26)
Von-Mises stress Fig(4.27)

Deformation is 0.00445mmand
Von-Mises stress is 1877 N/mm^2

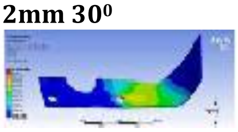
2mm 15^0

Total deformation Fig(4.28) Von-Mises stress Fig(4.29)

Deformation is 0.0135mm and Von-Mises stress is $962.9N/mm^2$

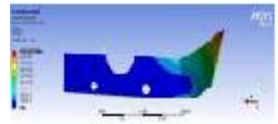
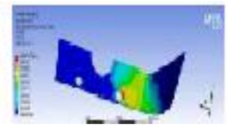
2mm 30^0

Total deformation Fig(4.30) Von-Mises stress Fig(4.31)

Deformation is 0.0454mm and Von-Misses stress is $405.08N/mm^2$

2mm 45^0

Total deformation Fig(4.32) Von-Mises stress Fig(4.33)

Deformation is 0.0565mm and Von-Misses stress is $604.65N/mm^2$

Case-1:- At the initial blade thickness is 2mm. The blade is analysed under constant force which is acting on the blade. The stress induced is more in this blade. The cutting face θ is changed to 15^0, 30^0 ,45^0. The blade thickness is less so stress induced is more as shown in above fig for 3mm thickness. Analysis is done for different angles and displacements are shown in above figure. So minimum stress is $405.08N/mm^2$.

Case-2:-1mm increased to 2mm i.e. 3mm so for this thickness also load and boundary conditions are same and same process carried out. To improve life of blade thickness is increased. As thickness increased so stress induced is less. Analysis here also done for 15^0, 30^0, 45^0 for all these angles minimum stress induced is 425.44 〖N/mm〗^2.

Case-3:- Another 1mm increased to 4mm then stress is increased to get less decrease the stress induced on the blade. Cutting angle at 15^0, 30^0, 45^0 and minimum stress induced is at 30^0 is $6.799N/mm^2$.

As thickness increases deformation also decreases this we can find out by ANALYSIS result. 4mm thickness, for 0^0 deformation is 0.154×10^{-4} mm, 150deformation is 0.176×10^{-4} mm, 30^0deformation of 4mm 30^0 is 0.196×10^{-4}mm, 45^0 deformations is 0.184×10^{-4}mm. So from all above comparison 4mm at 30^0 stress induced is less.

7. CONCLUSION AND FUTURE SCOPE

ANALYSIS results show that stress induced in one blade differ from another blade by angle as well as by thickness. By comparing 2mm, 3mm, 4mm results the minimum stress induced is at 4mm 30^0. So by this it's proved that as thickness increases the stress induced is decreases. So from the comparison 30^0designs is a safe design. The blade life increases at 30^0. Power consumption reduced. Force required is also less.

Future scope

- By using composite material in blade design and analysis can be done.
- Optimisation can be done for reducing the weight.

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