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Design and Development of Traditional Cultivator For Soyabean Farm

Anand Karde[1], Swapnil Karle[2],Suhas Nika*m*[3] ,Shubham Kale[4] , Mr Dipak Wagh[5]

[1,2,3,4]UG Student, Department of Mechanical Engineering, Sinhgad Institute of Technology and Science, Narhe.

[5]Asst. Prof., Department of Mechanical Engineering, Sinhgad Institute of Technology and Science, Narhe

[1]anandkarde111098@gmail.com

[2]swapnilkarle999@gmail.com

[3]nikamsuhas777@gmail.com

[4]shubhamkale04@gmail.com

Abstract

This research paper is related to the designing of Cultivator for Soybean farming. The basic objective of this machine is the cultivation and fertilization simultaneously and flip the soil. The agricultural industry has always been the backbone of India's sustained growth. As the population of India continues to grow, the demand for rapid production grows as well. Hence, there is a greater need of farm equipment's that can boost the production. Our machine and machine tool will help to achieve multiple processes simultaneously. Therefore it will decrease overall time required for the production. The machine consists of various parts such as hopper, chain sprocket and cover, spring, shank, etc.

Keyword- Hopper, Shank, Fertilizer.

I. INTRODUCTION

For roughly previous 80 years, tractors have been the main machine in the farming. These robust, weather resistant and powerful machines reliably undertake the required tasks. Modern tractors are safe, comfortable and can be modified. There are hardly any other automobiles that can be used in the summer, as well as during snow. Majority of the processes in any plant production is done by the tractor. The most common task for a tractor is to pull; the
word tractor comes from the Italian word "trahere", which means to pull. A tractor pulls ploughs, harvesters, trailers, and in emergencies they can pull cars that are stuck in ditches.

High tech equipment is required in the agricultural industry, even for stationary applications. Barn technology provides a large range of interesting and robust equipment. In addition to the range of specialised box and gate systems, the machines in the barn are the ones providing the revenue. The agricultural industry contains equipment for all areas of the livestock sector including milk machines, feeding equipment, modern lighting systems and efficient cleaning equipment. There are constant developments, even in the field of ventilation, hygiene, water distribution or comfort. The livestock sector is becoming even more important. Many manufacturers provide special systems for cattle of pig breeding,

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that can help prevent illnesses and other damages to the animals. What is particularly interesting about used equipment in barn technology is that they can always be resold. After being thoroughly cleaned and sterilised, approved equipment for animal breeding can be used again without hesitation.

A tractor is only as good as its accessories. Modern sowing and harvesting machines are more than just mere racks that are pulled behind a tractor. They also contain complex mechanics that need to be good enough for the hard work requirements of the agricultural industry. There spectrum of machines is very large. Whether it is a cucumber or carrot harvester, harrow, roller or snow pusher, there are appropriate attachments available for all applications. The major occupation of the Indian rural people is agriculture and both men and women are equally involved in the process. Agriculture has been the backbone of the Indian economy and it will continue to remain so for a long time. Even in the pandemic situations agriculture industry is not stopped.

The government of India appointed a commission to assess the feasibility of increasing the crop productivity under prevailing Indian ecological conditions. In order to develop the standard of living of small farmers we should make the machines with low cost. This will help small farmers to implement the recent modern machines for farming purposes. Our proposed multipurpose sowing machine will be used to sow different types of seed like groundnuts, corns, etc. So in this work an attempt has been made to provide the multipurpose sowing machine at low cost. Thus this project deals with design and fabrication of a smart seed sowing machine tool which can fertilize the farm and cut the grass simultaneously based on the pitch given by the farmers.

The basic function of multipurpose farming machine is to sow the seed, reduce wastage of seed and loosen the soil. Our machine archives all these three things in the rows at required depth and also with maintained distance between the seeds and provide proper compaction over the seed. A multipurpose farming machine is a device that plants or sows the crops, it digs a furrow places the seed or seeds into the furrow and covers it. Multipurpose farming machine ensures uniformity in seed broadcasting and saves time and money.

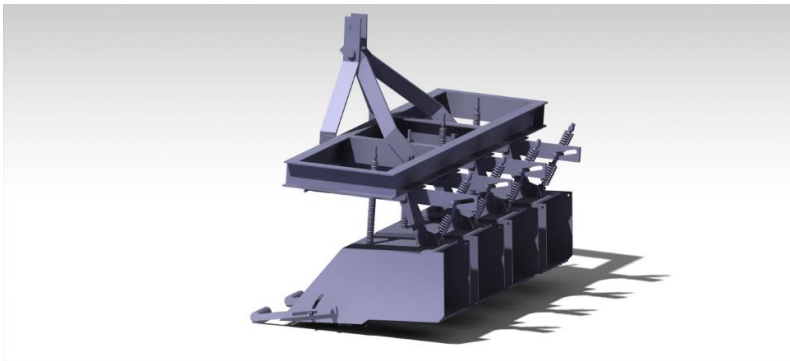

Fig.1 3D Model of Cultivator

II. SHANK

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Shank is the most important part of any kind of cultivator. The main processes such as cultivation, fertilization and flipping of the soil take place in the shank. To do the above respective processes, several elements have been designed to have the process done properly and efficiently.

The frontal portion of the shank works like a sieve; it separates the grass, larger particles from the fine, and medium-grained soil. The grass is then collected at the back of the shank where a storage tank is placed. After the storage tank is filled to the limit, a simple opening mechanism gives direct access to remove the grass.
The forces acting on the shank will start from the sieve. Hence the sieve is made sufficiently strong enough to tolerate the load acting on it. The springs are attached to the shank, which works as a link between the shank and the cultivator frame.

The spring keeps the shank at a specific level. The spring acts as two force member and lowers the stresses on the cultivator frame and the shank, by absorbing most of the forces during cultivation.

Below is the result of the analysis for the shank

By considering all the factors, AISI 1018 material mostly fulfils our requirement, so we selected AISI 1018 as the material for designing the shank. Following are the mechanical properties of AISI 1018.

PROPERTIES	AISI 1018
Density (gm/cc)	7.87
Tensile strength	440 MPa
Yield strength	370 MPa
Modulus of rigidity	205GPa
Shear modulus	80GPa
Poisson ratio	0.27 to 0.3
Elongation in break	18%
BHN	126
Rockwell Hardness	71
Thermal conductivity	51.9 w/mk

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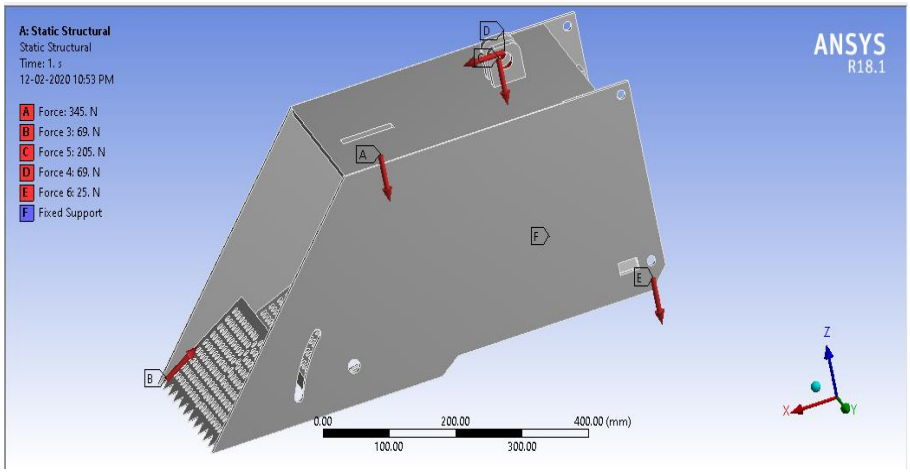

Fig.2 Different loads on Shank

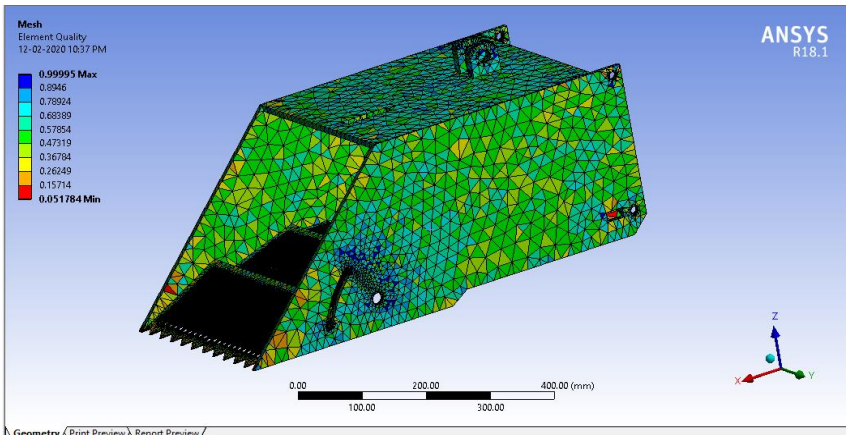

Fig.3 Fine Meshing of Shank

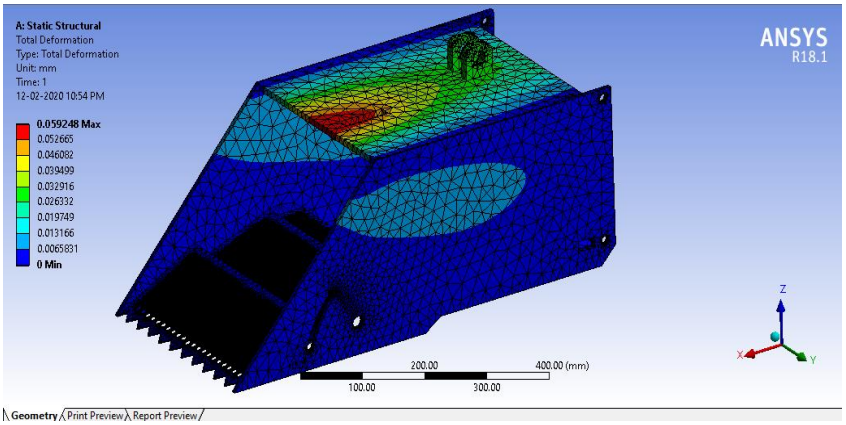

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Fig.4 Total deformation for given loading condition

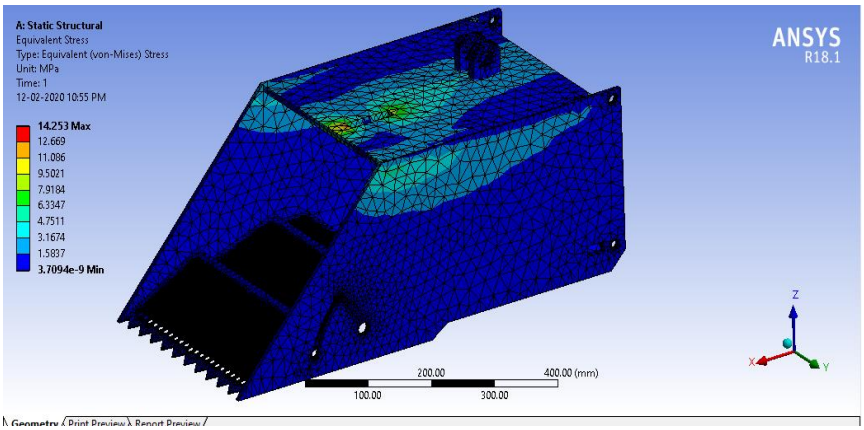

Fig.5 Equivalent stress

Note - Before the starting of the cultivation process, the sieve should be adjusted according to the soil and the farm level. Not considering the adjustment will cause an increase in the stress of the sieve joint and can cause a failure or breaking of the joint.

The below calculation is according to the maximum force in most of the scenarios will have

Force Distribution on support Beam –

Given Parameter -

Weight of Frame – 45 Kg

Weight of Tank – 10 Kg

Weight of Tank – 40 Kg (with Fertilizer)

Factor of safety – 2

Total Weight – 170 Kg

No. of Horizontal Support = 4

Calculation –

Weight on Each Support Beam –

$W = \frac{170}{4} = 42.5$ Kg

$F = 42.5 \times 9.81 = 416.92$ N

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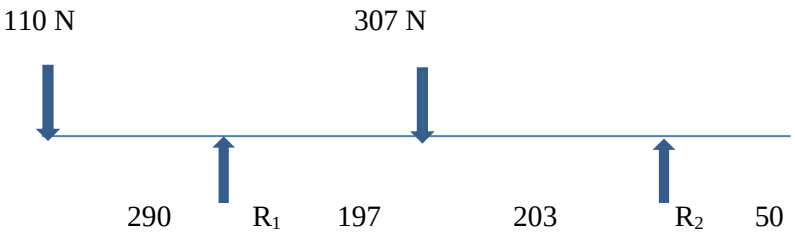
Force Distribution Diagram of Beam

Case - 1 When load on Rear Spring



$\sum Force = 0$

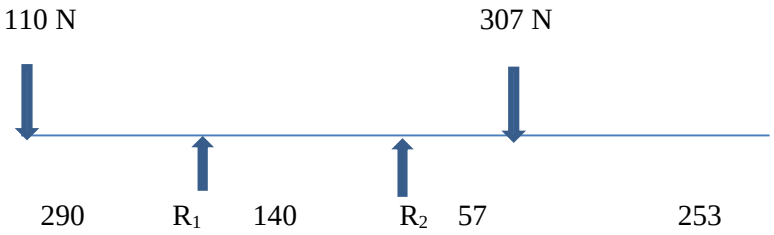
$110+307+R_1 + R_2 = 0$

$\sum M = 0$

$110 \times 290 + R_2 \times 410 - 307 \times 107 = 0$

$R_2 = 72$ N, $R_1 = 345$ N

Case – 2 Load on inclined When member.



$\sum Force = 0$

$110+307+R_1 + R_2 = 0$

$\sum M = 0$

$110 \times 290 + R_2 \times 140 - 307 \times 197 = 0$

$R_2 = 205$ N, $R_1 = 212$ N

Therefore, we consider the maximum force on front spring are **F = 345 N** and on Rear spring are **F=72 N.**

Spring calculation: -

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Front Spring –

Given Parameter-

Material – Stainless 17-7 ASTM A303, (G = 75.68 GPa, τ = 771.24 MPa)

F_{max} = 348 N, F_{min} = 90 N, Deflection (ɗ) = 95 mm

Spring Index (C) = 6.33 …….. (Spring Manufacturers Catalogue)

$K_w = \frac{4C-1}{4C-4} + \frac{0.651}{C}$ = 1.24

$\tau = K_w \left[\frac{8FC}{\pi d^2}\right]$

d = 3 mm

D_m = C × d = **19 mm**

Spring Rate (K) = $\frac{Fmax-Fmin}{ɗ}$ = **K= 2.71**

$K = \frac{Gd}{8nC^3}$

Number of Active Coils -**N = 41**

N_t = 43 (Square Grounded)

Solid Length = L_s = (n+2) d **= L_s = 129 mm**

Free Length =L_f = L_s + ɗ + 0.1×ɗ =**L_f = 231 mm**

Pitch Of coil = P = $\frac{Free\ Length-2d}{N}$ **= P = 5.48**

Rear Spring –

Given Parameter-

Material – Stainless 302 ASTM A313, (G = 68.599 GPa, τ = 784.2 MPa)

F_{max} = 130 N, F_{min} = 106 N, Deflection (ɗ) = 60 mm

Spring Index (C) = 11.17…….. (Spring Manufacturers Catalogue)

$K_w = \frac{4C-1}{4C-4} + \frac{0.651}{C}$ = 1.132

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$\tau = K_w \left[\frac{8\,FC}{\pi d^2}\right]$

d = 2.3 mm

$\mathbf{D_m} = C \times d =$ **25.7 mm**

Spring Rate **(K)** = $\frac{Fmax-Fmin}{d}$ **= 0.383**

$K = \frac{Gd}{8nC^3}$

Number of Active Coils **-N = 37**

$\mathbf{N_t}$ **= 39** (Square Grounded)

Solid Length = $L_s = (n+2)\,d =$ **L_s = 90 mm**

Free Length = $L_f = L_s + d + 0.1\times d$ **= L_f = 156 mm**

Pitch Of coil = P = $\frac{Free\ Length-2d}{N}$ = **P** = **4.09**

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