# Design Consideration and Calculations of Portable Sugarcane Planter

[1]S.S. Tambade, [2]A. G. Bhongale, [3]Ashitosh Jadhav, [4]Aishwarya Mishra, [5]Suraj Kahate, [6]Tejshri Gavhane

[1, 2] Asst. Professor, Mechanical Department, Bharati Vidyapeeth's College of Engineering Lavale, Pune, Maharashtra, India,
[3,4,5,6] Student, Mechanical Department, Bharati Vidyapeeth's College of Engineering Lavale, Pune, Maharashtra, India.

***Abstract :*** India is one of the greatest producers of sugarcane. In India, most of the cultural practices associated with sugarcane production are undertaken by using traditional tools, equipment and machinery. Sugarcane planting is very labor intensive job and involves considerable human drudgery. About 25-30 percent of the cost is for manual labor. In comparison to traditional practices, there is a cost saving of about 30 to 60% under mechanized farming systems. In India considerable R & D work for design and development of agricultural implements and machinery for few operations has been developed. However, the adoption of these machineries have not been up to the desired level especially, in the area of sugarcane planting. Due to the high cost of machines and skilled labor requirement, these kinds of machines are less in use. Therefore, an inexpensive sugar cane planter for eliminating excessive manual labor is required to plant sugarcane setts. In order to achieve uniform crop stand, correct seed rate, appropriate depth of setts placements and uniformity of setts with required overlapping are important. This project aims to design and fabricate a sugarcane planter to reduce the labor cost and benefit specifically the small scale farmers. In addition to this, it also aims at reducing the harmful emissions and turn up as an environmental friendly machine.

***Index Terms*** **- Sugarcane, Setts, Skilled Labor, Cost, Harmful Emissions.**

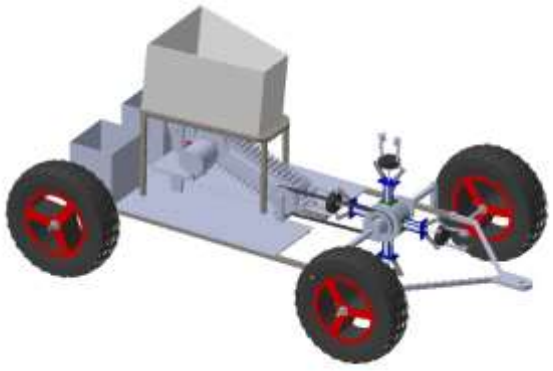
## I. INTRODUCTION

India stands second in sugarcane production in the world next to Brazil. Sugarcane is grown on about 4.7 million hectares (Mha) (April, 2020) with an approximate production of 353.85 million tones of cane with an average yield of 69.4 tones/ha (2019-20). The sugarcane is labour intensive crop and require huge labor force for various unit operations like planting which consumes 16 to 20% of the production cost of sugarcane. A farmer has to spend Rs 4,000 to 4,500 only for planting of sugarcane in one hectare excluding cost of land preparation, seed, fertilizer and insecticide.

In most of the villages in India, planting is done manually. Therefore, there is an urgent need of introduction of modern machineries for sugarcane planting having high advantages over conventional planting. Despite these advantages, the use of these machineries is limited due to high initial cost and requirement of skilled labor.

In semi mechanized system, harvesting and distribution of seeds in the furrow is done manually. Accuracy of distribution of seeds in the furrow completely depends upon the skill of the worker. Machine speed also affects the accuracy. So, in order to avoid this, huge improvement in the sugarcane planting is required.

The machine is compact in size which is used in smaller lands and operated by single person. Machine consists of a conveyor, storage tank, and 4 pneumatic arms. The seeds to be sown are filled in the storage tank which pass on to the conveyor belt through a slot provided in the storage tank which is in a slanting position. The seeds are further taken by the gripper cum actuator mechanism which picks the seeds and places them into the soil. Thus, the manual work is reduced and which in turn, reduces the time consumption for sugarcane planting and increases the production rate.



## II. PROBLEM STATEMENT

In India, there are a lot of problems regarding cost and efficiency of agricultural instruments as well as the machines which are currently used produces lots of environmental pollution. To overcome these problems, we require equally efficient battery operated sugarcane planters.

## III. OBJECTIVE

1. To minimize the weight of the existing machine
2. To eliminate environmental pollution
3. To reduce cost of labour and minimize human intervention
4. To develop an automated machine
5. To decrease the time consumption rate of planting
6. To provide a better option to the farmers which is economical and easy to operate

## IV. LITERATURE REVIEW

[1] Indian Institute of Sugarcane Research (IISR), Lucknow has developed various types of sugarcane planters like Sugarcane cutter planter which weighs about 347kg and is a tractor mounted arrangement which can be drawn by 26kw tractor and is a three row planter and need 5 persons to operate this machine. It operates for the average length of setts being 34.5cm. The total cost of planting is 708Rs/Hectare with a speed of 2.3km/hr where as conventional method can cost up to Rs.3570. Having row to row spacing equal to 75cm. This machine also consists of grounded wheel-driven cutting and fertilizer metering units. Here, curved blades are used to cut the cane.

[2] S. M. Nalawade, A. K. Mehta, Nikhil Sane, Nikhil Joshi (2019) developed a faster sugarcane planter for covering maximum area under drastic condition. It is a tractor operated automatic sugarcane sett planter developed to achieve faster operational speed. It uses BLDC electric motor of 400W. This machine is capable of singulation of setts as well as laying them in furrows. It can be operated with 45 HP tractors at a speed of 4.5 km/hr and able to plant area of 0.57hectare/hr. The different mechanisms involved are hopper, conveyor, singulation mechanism and drive mechanism. It was observed that the field efficiency of sugarcane sett planter is 73% and operated at a speed of 4 to 5 km/hr and the seed rate applied was 5550kg/hectare.

[3] Umesh S. Patkar, Rajesh W. Lanjewar, DMS Group, CMERI, Durgapur, India has studied various sugarcane planters. One of which is a tractor operated two row ridger type sugarcane cutter planter which is hydraulically controlled and the power is derived through tractor PTO for sett cutting and fertilizer metering. The main drawback encountered is that even if the tractor is stopped during planting, the planter still plants extra canes at the same place, which is undesirable. In case of the Julien mechanical planter, the planting rate lacks in consistency due to too many moving parts. Whereas the slat type mechanical planter having high maintenance which in turn, limits its acceptance. By observing all these drawbacks, a single row sugarcane planting machine has been developed which is an attachment to the tractor. The power source being a 35HP tractor with 0.25 hectare/hr effective field capacity with a labor requirement of two persons. This machine will enhance growth production and productivity.

[4] Abrar Ahmed Choudhary, D. Mohan Kumar, K. Prithviraj, Reuban David, have designed a four wheel electric vehicle. It has a simple concept and all types of light weight materials are used in its manufacturing. In addition to this, the vehicle does not emit any pollutants nor require oxygen unlike IC engines. It runs fully on electricity having a capacity to carry 5 passengers + 1 driver i.e. load carrying capacity is approximately 360 to 370kg. This paper also gives us information about three types of electric vehicles:-

1. Those that are directly powered from an external power station.
2. Those that are powered from on board electric generator
3. Those that are powered by stored electricity

In an electric vehicle, DC current is fed to the inverter which is converted into AC current and is connected to a 3-phase AC motor which runs the vehicle.

[5] Sompot Khomkaew, Pracha Bunyawanihakul, Isara Chaorakam (2014-15) carried out an experiment on sugarcane planter in a field of 20 x 100 $m^2$ area. It was discovered that the fuel consumption rate of the sugarcane planter was at 123m/l at a tractor speed of 3.2616km/hr with a revolution of 3200 rpm. The prototype sugarcane planter is suitable to be installed on a 33.337 HP tractor. However, the power requirement of tractor is not appropriate to use with an agricultural tool because the end result will be an over-fuel consumption rate and pollution

[6] Srinivasa Kannan J. and Sudarshan V. developed a self-charging electric vehicle which generates the electric power required to drive the vehicle during the running condition by means of two auxiliary power sources. One of the sources is dynamo and the other being a horizontal windmill. The dynamo is coupled with the driving motor and the windmill is placed in front of the car. This machine provides noiseless operation as well. It appears to be light in weight. It is better than the existing electric vehicle in such a way that it is a self-charging vehicle which uses a current regulator to charge the battery simultaneously.

[7] Chaithanya B. V, Siva Subba Rao Patange, Sowmia Devi M, Panbarasu K. and Joyti B prepared this paper which aims in demonstrating the importance of material selection in engineering design in all aspects. This testing i.e. tensile testing of aluminium is performed to ensure that the material will remain stable throughout the life of the product. Tensile testing is one of the simplest and most widely used mechanical test.

[8] G.D. Shelke, S.S. Borikar, M.P. Awathale, A.P.Khante and Mrs. P. M. Zode carried out a research on design of sugarcane harvesting machine as 65 to 70% of Indian population depends upon agriculture and thus, in order to fulfil the future demands, there is a need of advancement in techniques and equipments of farming at economic cost and taking all this under consideration this machine is developed which works with less effort and in less time reducing the cost of labour required for seed sowing and fertilizer placement varying the cutting force of sugarcane from 29.14 to 106.57 N.

[9] Mr. Rohit J. Masute, Dr. Sharad S. Chaudhari, Prof. S. S. Khedkar , developed a machine which aims to benefit small scale farmers for sugarcane harvesting by reducing farmer's effort and to increase production of agricultural products. It is a petrol engine driven, manually operated machine and can cut canes at a faster rate. This harvester can cut the sugarcane above ground level i.e. 5-6 inches. The total cost of harvester is about Rs. 28,000 which can be easily recovered by harvesting two and half acre. In addition to this, only 2-3 labors are required. Also, the productivity is increased.

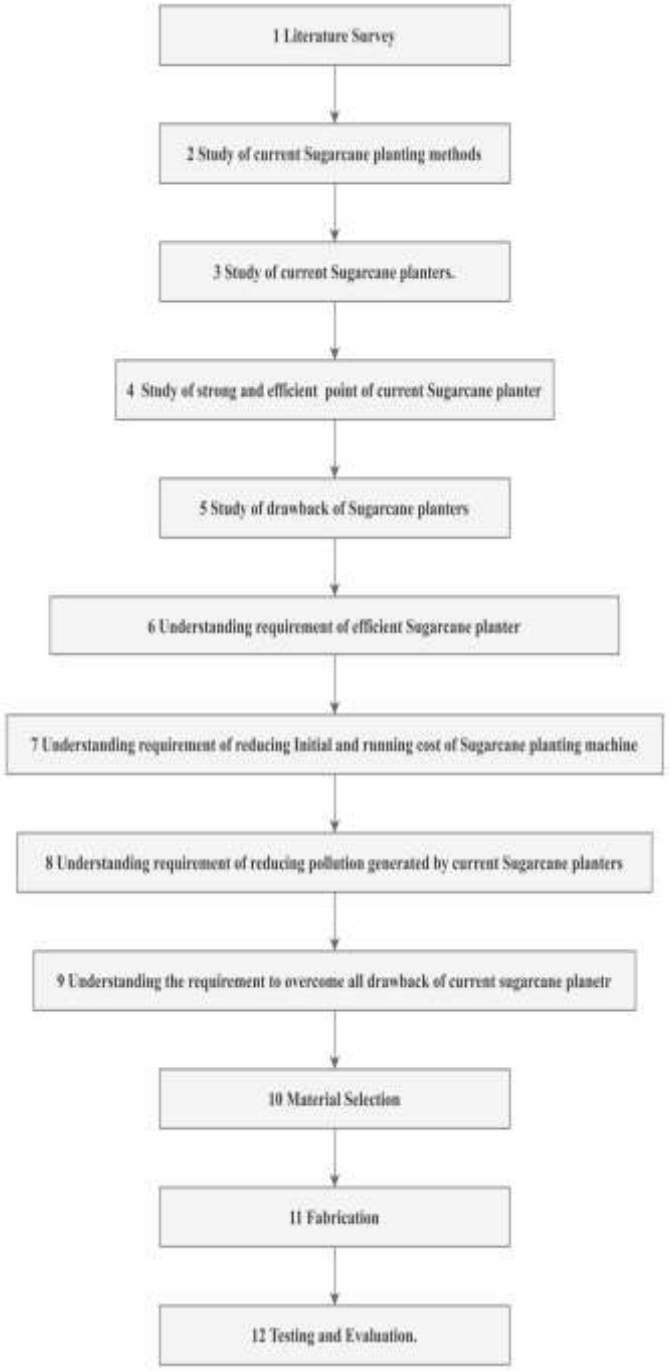
[10] M.V. Ramesh, G. Vijay Kumar, G. Diwakar carried out the design and fabrication of solar electrical vehicle system. In this paper, an overview for the fabrication of electric vehicle is presented. The sections elaborated in this paper are namely Building of Chassis, Axle, and Steering Structure etc. The main driving system is the permanent magnet brushless DC motor (PMBLDCM) used as electric variable transmission system. Unlike vehicles with combustion engines, electric vehicles do not produce exhaust gases during operation. Thus, making the electric vehicles M.V. Ramesh, G. Vijay Kumar, G. Diwakar carried out the design and fabrication of solar electrical vehicle system. In this paper, an overview for the fabrication of electric vehicle is presented. The sections elaborated in this paper are namely Building of Chassis, Axle, and Steering Structure etc. The main driving system is the permanent magnet brushless DC motor (PMBLDCM) used as electric variable transmission system. Unlike vehicles with combustion engines, electric vehicles do not produce exhaust gases during operation. Thus, making the electric vehicles

## V. METHODOLOGY

The design and fabrication work of sugarcane planter was done with the study of current available sugarcane planter and collection of data regarding the need for efficient sugarcane planter which operates with less human interference, is more efficient with low initial and final cost.

The flow chart depicts the actual action plan carried out in order to design and fabricate the sugarcane planter.

Afterwhich, literature survey and data collection session was conducted to decide a possible improvement and solution on the drawbacks present in current sugarcane planters.


1 Literature Survey
2 Study of current Sugarcane planting methods
3 Study of current Sugarcane planters.
4 Study of strong and efficient point of current Sugarcane planter
5 Study of drawback of Sugarcane planters
6 Understanding requirement of efficient Sugarcane planter
7 Understanding requirement of reducing Initial and running cost of Sugarcane planting machine
8 Understanding requirement of reducing pollution generated by current Sugarcane planters
9 Understanding the requirement to overcome all drawback of current sugarcane planetr
10 Material Selection
11 Fabrication
12 Testing and Evaluation.

## VI. MATERIAL

The design of Sugarcane planter is based on important factors affecting the planting process of previous planter. The mechanism is designed for planting sugarcane with less human interference without affecting its performance.

The previous planters are having heavy planting setup due to use of tractors. To overcome this problem, we need a lightweight planting setup.

Early lightweight vehicle design concepts were attempting to reduce vehicle weight by substituting some of the cast iron and steels used in vehicles with lighter material like magnesium or aluminium. Recently, high strength steel and plastic composite materials emerge as lighter weight alternatives with more acceptance due to the reducing trend in their prices and the new developments in their manufacturing.

The physical properties of sugarcane sett viz. length, diameter, weight and bulk-density are important for determining size and shape of machine components. Static coefficient of friction as well as dynamic coefficient of friction between setts and the material of construction of mechanism are important for choosing material, shape and slopes of stationary surfaces and also for calculating the driving forces for operation of mechanism.

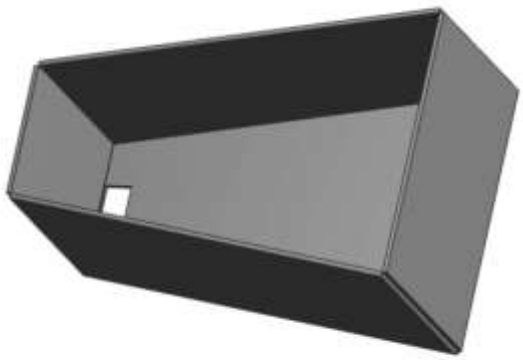
We are using a material which can withstand a drastic situation such that in wet soil as well as hot climate. By considering all the suitable factors for design of sugarcane planter, we select the material with light weight with minimum cost which can sustain in all environmental conditions.

### Hopper

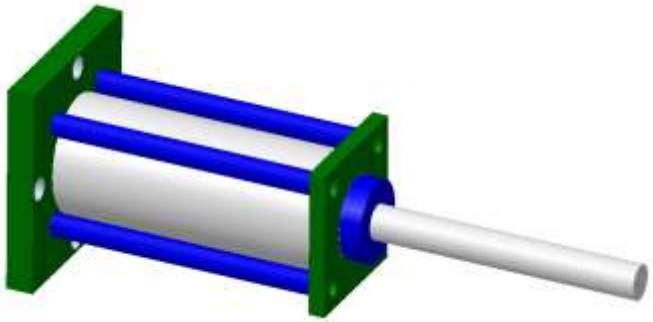
A hopper is a large, pyramidal or cone shaped container used in industrial processes to hold particulate matter or flow-able material of any sort, like dust, gravel, nuts, seeds etc. and can then dispense these from the bottom when needed. Hoppers are used in many industries to hold material until it is needed, such as flour, sugar or nuts for food manufacturing, food pellets for livestock, crushed ores for refining, etc. Dust hoppers are employed in industrial processes that use air pollution control devices such as dust collectors, electrostatic precipitators, and fabric filters. Most hoppers are made of steel.

### Material for Hopper:

Most hoppers are made of plastic, metal, or composite materials. Plastic hoppers are made of acrylonitrile-butadiene-styrene (ABS), acrylics, polyethylene (PE), polypropylene (PP), or polyvinyl chloride (PVC). Metal hoppers are usually made of aluminum, steel, stainless steel, or steel wire. Hoppers, dumpers and tippers that are made of fabric, foam, glass, paper, or cardboard are also available from some hopper manufactures.



**Pneumatic Cylinder**



Pneumatic cylinder(s) (sometimes known as air cylinders) are mechanical devices which use the power of compressed gas to produce a force in a reciprocating linear motion. Like hydraulic cylinders, something forces a piston to move in the desired direction. The piston is a disc or cylinder, and the piston rod transfers the force it develops to the object to be moved. Engineers sometimes prefer to use pneumatics because they are quieter, cleaner, and do not require large amounts of space for fluid storage. Because the operating fluid is a gas, leakage from a pneumatic cylinder will not drip out and contaminate the surroundings, making pneumatics more desirable where cleanliness is a requirement.

**Gripper**

The basic job of a gripper is to 'grip, hold and release' the required object/job/material. A pneumatic gripper is a specific type of pneumatic actuator that typically involves either parallel or angular motion of surfaces i.e. tooling jaws or fingers that will grip an object. The griper can be used as the part of a 'pick and place system' which will allow a component to be picked up and placed elsewhere during the process.

Types of pneumatic grippers: The most popular types pneumatic grippers are 2 jaws parallel and 2 jaw angular gripper styles. Parallel grippers open and close parallel to the object that it will be holding. These are the most widely used grippers. Angular grippers move the jaws in a radial manner to rotate the jaws away from the object and therefore require more space. There are also 3 Jaw and toggle style grippers that are designed for more specific handling requirements.

We have used the 2 jaw angular type gripper. A 8 bar mini DC air compressor is used to provide pressure to the pneumatic cylinder in order to ensure pick and place action of gripper. The four gripers are attached in a manner such that they are perpendicular to each other such that, each of them are of same dimensions which are mounted on a shaft through bearing to achieve rotational motion to the attachment.

**Conveyor**

A conveyor system is used in many industries as a standard piece of mechanical handling equipment. It allows quick and efficient transportation of different materials and products. Conveyors are usually fixed into different positions with other equipment's. There are a variety of options to run the conveying system including hydraulic, mechanical and fully automated system. There are different types of conveyor system like belt conveyor, chain conveyor, roller conveyors, overhead conveyors, aeromechanical conveyors, bucket conveyor, screw conveyor, drag conveyors, chute conveyor.

This project has made the use of belt conveyor. It is a rectangular shaped belt inclined at 210 having a length of 609.6 mm and 100 mm wide. The thickness of the belt is 10 mm. Slots of 5mm thickness are mounted whole along the length of the conveyor so that the sugarcane sett will easily fit within the spaces in order to prevent mixing of the setts and to maintain the proper flow of setts through the conveyor to the gripper mechanism. The gap between two adjacent slots is 10mm. The inclination of the conveyor is maintained to its minimum angle to prevent the setts from falling off the conveyor. Brushless DC motors are used for rotary motion as speed control is needed.

**Electric Vehicle**

Energy and environmental issues are major problems in today's world. It is believed that adoption of electric vehicles may reduce the impact of our concerns. Gasoline engines are creating high pollution levels and to reduce these levels in the cities, idea of replacement of conventional vehicles with electric vehicles is employed. The main objective is to use environmental friendly vehicle while remaining competitive in terms of performance, reliability, running cost and customers' expectations.

In this project, the idea is to develop the mechanization of small scale sugarcane planter. The machine components are mounted on a strong chassis. The chassis is made of mild steel angle bar of dimensions 50 X 50 X 3 mm, the dimensions of chassis frame is 1220 X 915 mm, 16 inch wheels are attached to the chassis. A lithium Ion battery of 12V 20Amp is mounted on the chassis to provide power to the driver motor. This battery also provides the power to run the compressor which provides pressure to the actuator. Motor specifications are decided on the power required to drive the vehicle. Four pneumatic arms are mounted on a shaft which is attached to the front side of the vehicle. Hopper is mounted on the vehicle with the help of support frame and conveyor is provided to supply sugarcane to the actuator.

**Controls**

DC motors:-

DC motor is commonly used as they can be powered from present direct current lightning power distribution system. A DC motor can be controlled over an extensive range using either variable supply voltage or by changing the strength of the current in field winding. Lightweight motors are used for convenient power tools and applications. The arrival of power electronics has made replacement of Dc motors with AC motors possible in many applications. A motor is an electrical machine which converts electrical energy into mechanical energy. The function of DC motor is that whenever a current carrying conductor is placed in magnetic field, it experiences a mechanical force.

Speed Control

Controlling the speed of a vehicle is very important factor in sugarcane planting operation. The speed controller is an electric circuit that not only controls the speed of an electric motor but also serves as a dynamic brake. That's why controller is a core component.

Battery

A lithium Ion rechargeable battery of 12V 20Amp is used for power supply. It stores the electrical energy generated and utilize it to run the motor. Rechargeable batteries can be recharged multiple times.

## VII. CALCULATIONS

We know,

**ω=v/r** **……Eq (1)**

Where,

ω= Angular Velocity
v= Linear Velocity
r =Radius of wheel

Also, V= maximum linear velocity for 1 Acre
Implies v= 4 km/hr = 4 X 5/18 m/s
V=1.111m/s

Again,

Wheel Diameter, d=16 Inch
d=16 X 0.0254m
d=0.4064m

[Since, 1 inch =0.0254m]
Therefore wheel radius, r= 0.4064/2 =0.2032m
Now, From eq(1) we have,

ω=v/r
ω=1.111/0.2032 $m^2/s$
ω=5.468 $m^2/s$

Again,

**ω=2πN/60** **……Eq (2)**

Where, N= speed of wheel in rpm
From eq(2),
5.468=2πN/60
**N=52.242 rpm**

Now, From Newton's Second Law of motion i.e. force is equal to the change in momentum per change in time,

**i.e. F=m X** **……Eq (3)**

Where, m= Total mass of the vehicle including setts
m=60 kg
Therefore, Eq(3) becomes,
**F=60 X 9.81 N**
**F= 588.6 N**

We know that a twisting force is required which tend to cause rotation.
Therefore the Twisting Force or Torque is given by

**T=F X r** **……Eq (4)**

Where, F=Force in Newton
r= Radius of wheel in meter
From eq(4) we get,
T=588.6 X 0.2032 Nm
**T=119.60 Nm**

Also we require input power to run the system which is given by,

**P= 2πNT/60** **…….Eq (5)**
P=2π X 52.242 X 119.60/60
**P=653.97 W**
**Based on these calculations, the motor and battery with required specifications are selected**

## VIII. ANALYSIS

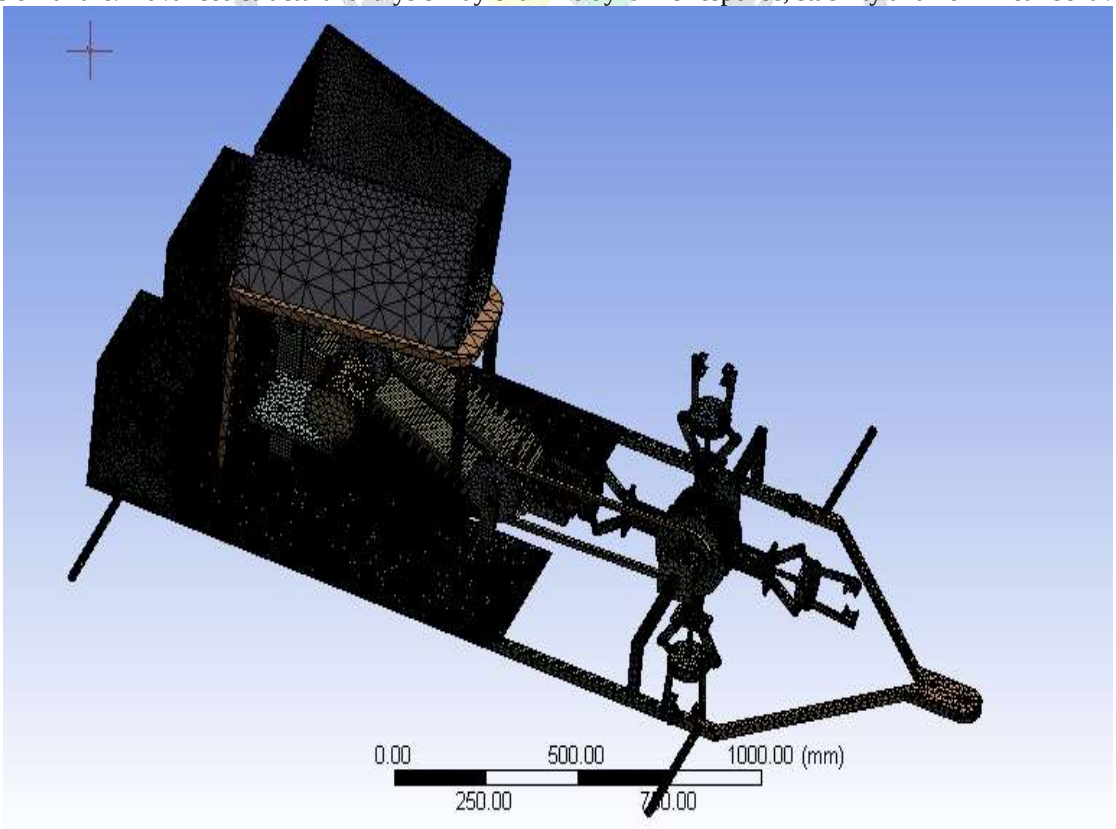
**Model Analysis:**

Analysis provides an overview of the limits of the response of a system. Used to determine the (Vibration characteristics) Natural frequencies and mode shapes of continuous structure. A continuous structure has on infinite number of degrees of freedom. The finite element method approximates the real structure with a finite number of DOFs. N mode shapes can be found for a FEM having N DOFs. Analysis generates a subset result for each natural frequencies and mode shape. As governed by the first law of thermodynamics, one form of energy is only converted to another. However, energy is neither created nor destroyed. In any mechanical system, when an external time-varying load is applied, it is equivalent to supplying the system with some kinetic or vibrational energy. This is transmitted through the system resulting in a displacement of the structure. However, due to the presence of friction, some of this energy is also dissipated as heat. To understand this process more physically, imagine that structure is in a constant state of motion sub-atomically. The energy supplied is transported from one part of the structure to the other through energy transfer by atomic processes. However, when the frequency of loading is the same as the averaged vibrational frequency of the atoms in the structure, the energy is transferred with minimum loss. In other words, one can think of it as two waves (one being the external load and the other being that of the internal atomic structure) that are being superimposed. When the frequencies are the same, they tend to add up. Therefore, it is important to know the frequencies at which the structure can behave erratically.

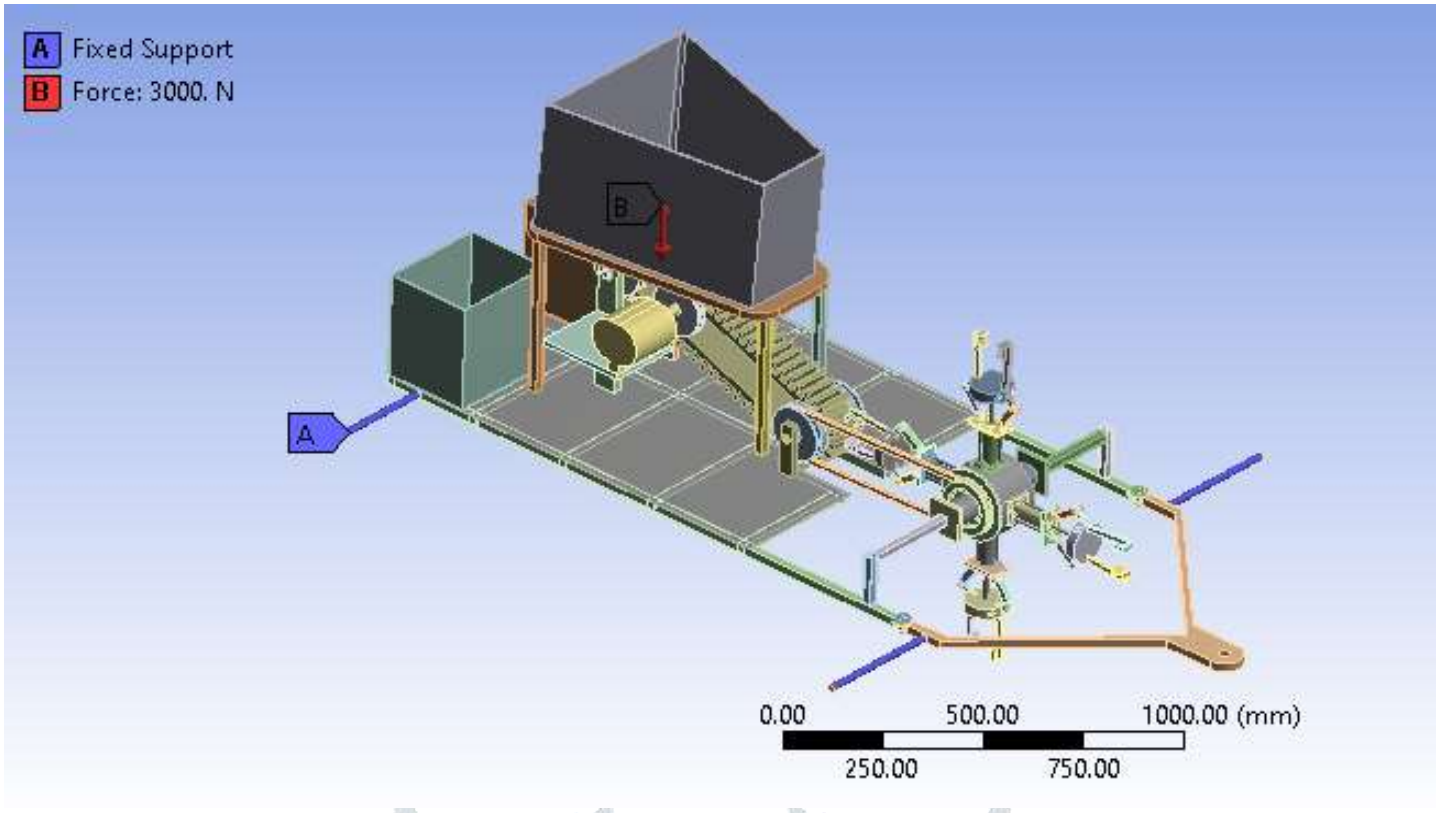
Every system can be described in terms of a stiffness matrix that connects the displacement and forces or system inputs. These frequencies are known as natural frequencies of the system. This also known as resonant frequencies. The resonant frequencies related to mechanical structure are known as mechanical resonance. Similarly every system has its own resonant frequencies at which resonance occurs. This resonance generates vibrations in machine. Due to vibrations machine life and operator safety reduce.

**Structural Analysis**

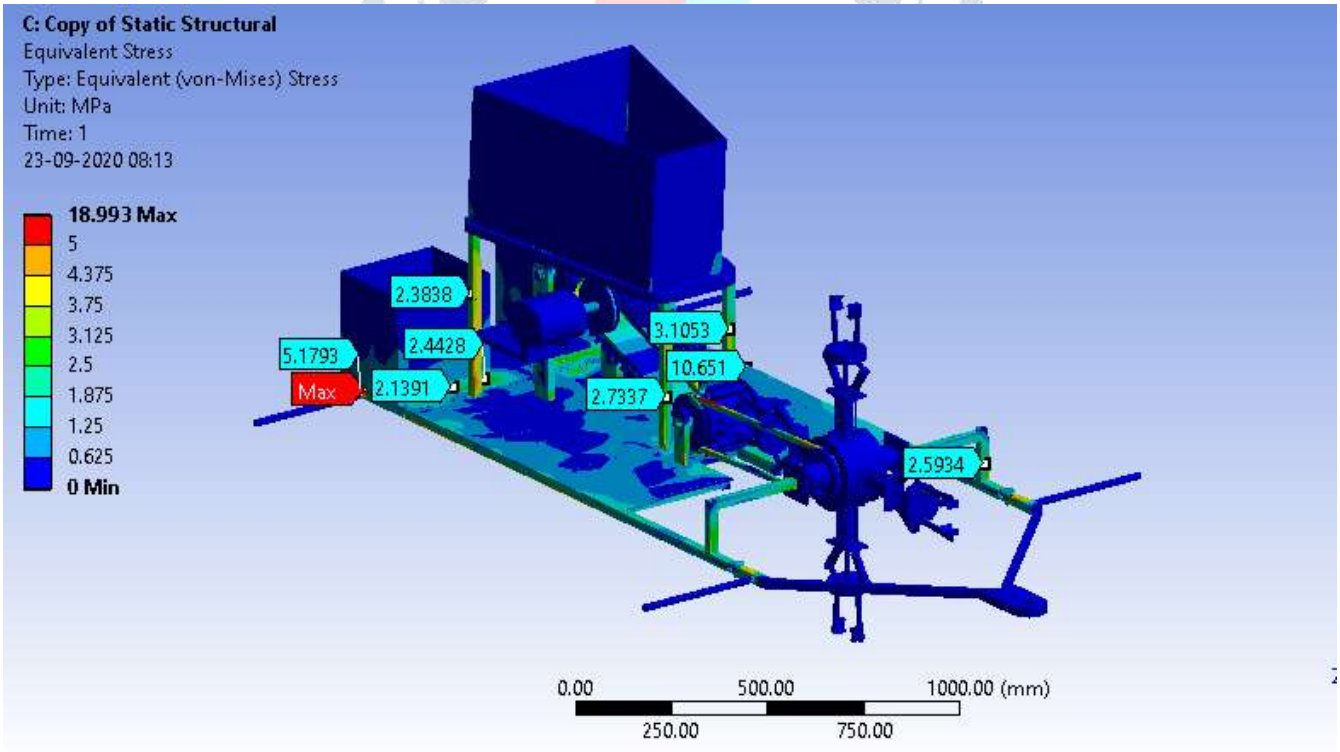
Structural analysis is the determination of the effects of loads on physical structures and their components. Structures subject to this type of analysis include all that must withstand loads. Structural analysis employs the fields of applied mechanics, materials science and applied mathematics to compute a structure's deformations, internal forces, stresses, support reactions, accelerations, and stability. The results of the analysis are used to verify a structure's fitness for use, often precluding physical tests. Structural analysis is thus a key part of the engineering design of structures. Loads: Once the dimensional requirement for a structure have been defined, it becomes necessary to determine the loads the structure must support. Structural design, therefore begins with specifying loads that act on the structure. There are two types of loads that structure engineering must encounter in the design. The first type of loads is dead loads that consist of the weights of the various structural members and the weights of any objects that are permanently attached to the structure. The second type of loads is live loads which vary in their magnitude and location. There are many different types of live loads like building loads, highway bridge loads, railroad bridge loads, impact loads, wind loads, snow loads, earthquake loads, and other natural loads. To perform an accurate analysis a structural engineer must determine information such as structural loads, geometry, support conditions, and material properties. The results of such an analysis typically include support reactions, stresses and displacements. This information is then compared to criteria that indicate the conditions of failure. Advanced structural analysis may examine dynamic response, stability and non-linear behavior.



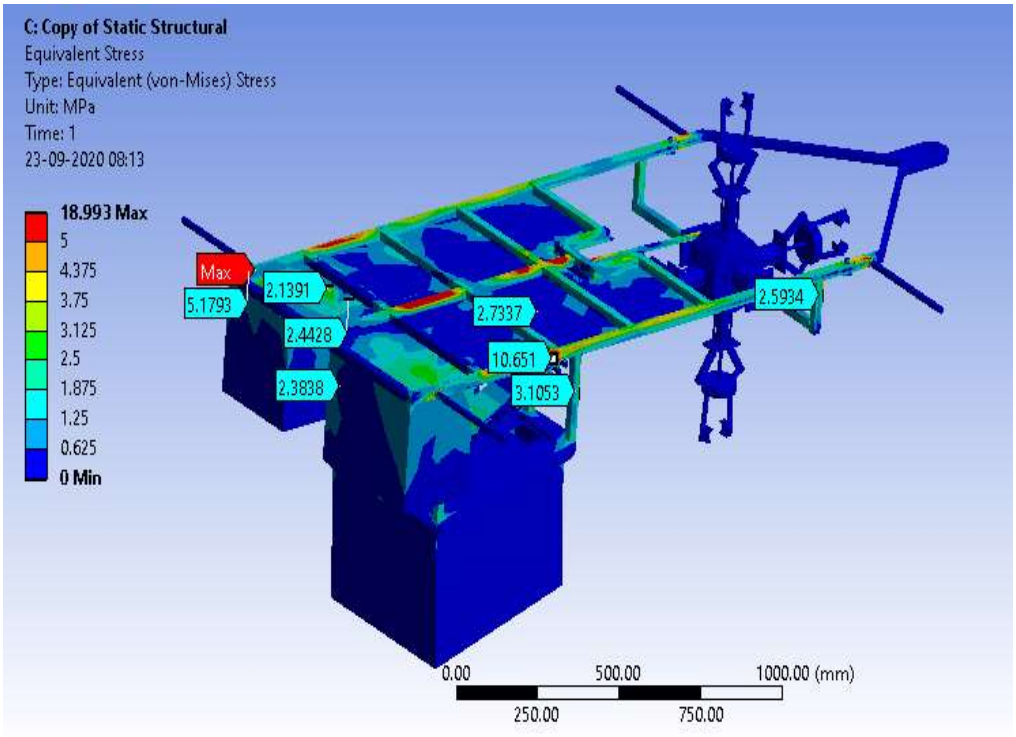

**Meshing**




**Load Applied**




**Stress Generated**




**Stress Generated**

**Analysis Conclusion:-**

The stresses obtained during the analysis are less than allowable stresses that is to be employed. Hence, the design is safe under the applied load.

**ADVANTAGES**

1. No harmful emissions due to the use of battery instead of IC engine.
2. Very less human/labour intervention is observed.
3. Due to less human interference, there is a decrease in labour cost.
4. It is a portable machine with less no. of parts as compared to IC engine operated vehicles.
5. No skilled labour required.
6. It is a less time consuming process.
7. The process is easy to be carried out.
8. It is light in weight, so there is less damage to the soil
9. Consists of a rechargeable battery. So, can be recharged anytime.
10. Less maintenance required

## IX. APPLICATIONS

1. Can work in muddy, loamy, wet soil.
2. Useful for small-scale farms with land up to 5 acre.
3. Can work in areas where labour availability is less.
4. Can work in uneven soil fields.
5. Can be used in any weather condition.
6. Can be a replacement for huge machineries.

## X. FUTURE SCOPE

1. In portable sugarcane planter, there are various areas in which further improvement can be done like increasing the storage capacity of hopper, automation of planting process and designing the control system of portable pneumatic system.
2. We can carry some improvements in control system of vehicle and pneumatic system.
3. Some work on proper control of vehicle can be done to make sure that controlling is easy for operator because it runs on uneven farm surface.
4. We can make improvement and research on adding new features e.g. soil preparation applications and other seed planting apart from sugarcane.

## XI. CONCLUSION

Thus, we successfully made the design consideration and calculations of Portable Sugarcane Planter Machine. As already said, the machine is eco-friendly and economical to small scale farmers. After the observation of performance of different types of sugarcane cutter planter, we observed that all currently available sugarcane planters require high power tractors to run. These high power tractors run on conventional fuel which produce high amount of pollution. Due to increasing cost of fuel, running cost of machine increases. These machines also have high initial cost. To overcome these drawbacks, we need a machine which runs on electrical vehicle and also have less initial and running cost.

The main objective of our proposed research is to design a sugarcane planter which gives result in terms of high productivity, low energy consumption and also has low running and initial cost. Appropriate machinery has been developed, but commercialization and wider adoption is required to capitalize the potential benefits to achieve it with less initial cost, small size and easy operation. This is very important in our country as majority of the farmers are small land holders.

The small scale battery operated sugarcane planting machine is designed and fabricated which makes the process faster and accurate hence, reduces labour required to operate the machine and in turn, reduces the labour cost. This machine will help farmers to overcome labour crisis in sugarcane planting. In addition to this, the machine reduces fuel cost along with maintaining the same productivity.

## ACKNOWLEDGEMENT

The authors would like to thank Principal, H.O.D and teaching staff of mechanical engineering department for providing their valuable guidance and support to carrying out this work.

## REFERENCES

[1] IISR Tractor Mounted Sugarcane Multipurpose planter, All India Coordinated Research Project on Farm Implements and Machinery Central Institute of Agricultural Engineering, Nabi Bagh, Berasia Road, Bhopal, India.

[2] Sompot Khomkaew, Pracha Bunyawanihakul, Isara Chaorakam, Performance test of sugarcane planter with minimum tillage at different densities of sugarcane leaf residues, National Agriculture Machinery Center, Kasetsart University, Nakhon Pathom,Thailand

[3] S. M. Nalawade, A. K. Mehta, Nikhil Sane, Nikhil Joshi, Faster Sugarcane Planter Machine for Shorter Planting Period under Climate Change, Director of Research, MPUAT, Udaipur.

[4] Umesh S. Patkar, Rajesh W. Lanjewar, A tractor driven mechanism for uniform planting of sugarcane, DMS group, Central Mechanical Engineering Research Institute, Durgapur, India

[5] Mr. Rohit J. Masute, Dr. Sharad S. Chaudhari, Prof. S. S. Khedkar, Design and fabrication of small scale sugarcane harvester, Department of Mechanical Engineering, YCCE, Nagpur, India.

[6] Abrar Ahmed Choudhary, D. Mohan Kumar, K. Prithviraj, Reuban David, Design and fabrication of four wheeled electric vehicle, B.Tech students, Assistant professor, Department of Automobile Engineering, BIST, BIHER, Bharati University, Chennai, India.

[7] Srinivasa Kannan Jeyakanthan, Sudharshan V, Design and fabrication of self-charging electric vehicle, U.G. student, Department of mechanical engineering PSVP college,Chennai, Tamilnadu, India.

[8] Chaithanya B. V, Siva Subba Rao Patange, Sowmia Devi M, Panbarasu K, Joyti B, Study on material selection for particular design, CSIR-National Aerospace Laboratories, Bengaluru-560017, India

[9] Murilo Aparecido Voltareli, Rouverson Pereira da Silva, Vicente Filho Alves Silva, Fabio Alexandre Cavichioli and Ariel Muncio Compagnon, Performance Mechanized set tractor-planter of sugarcane planting in two operation shifts, UNESP-Univ Estadual Paulista, Campus de Jaboticabal, SP, Brazil.

[10] Mr. Kushagra H. Patel, Mr. Pragnesh G. Patel, Mr. Sagar R. Patel, Mr. Nikesh K. Parmar, Mr. Jidar R. Tailor, A review paper on Design of sugarcane Transplanter Machine, Department of Mechanical Engineering, Vidhyadeep Institute of Engineering & Technology Anita (Kim), Gujarat.

[11] M. Sampathkumar, E. Deepak kumar, J. Gokul Prasanth, R. Gokul, D. Gokulnath, Design and fabrication of sugarcane plantation machine, Department of mechanical Engineering, Nandha Engineering College, Erode-52,Tamilnadu, India.

[12] G.D. Shelke, S.S. Borikar, M.P. Awathale, A.P.Khante and Mrs. P. M. Zode, 'Design of Sugarcane Harvesting Machine'

[13] M.V. Ramesh, G. Vijay Kumar, G. Diwakar,M.V.Ramesh , G.Vijay Kumar , G.Diwakar Design And Fabrication Of Solar Electrical Vehicle System.