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Development and performance evaluation of Self Propelled Onion Harvester

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ABSTRACT

The onion harvesting machine is based on reducing the amount of effort required for onion harvesting as well as for saving cost required in harvesting, especially for small scale farming. There purpose of designing and fabrication of such small equipment is that it fulfills requirements of harvesting and reduces the cost of it. Onion harvesting machine contains simple mechanisms with effective manually handling system that need only human efforts for operations. The purpose behind this is to just reduce production cost of onion manufacturing. By that farmer can get more output & income especially considering small scale farming.

INTRODUCTION

Onion is an important vegetable crop in India and is an integral component of Indian culinary. This report analyzes on self propelled onion harvesting machine. In India onion is grown in three crop seasons, namely kharif (harvested in October-November), late kharif (January-February) and rabi (April–May). Rabi season crop is the largest accounting for about 55 % of annual production with kharif and late kharif accounting for about 45%. Major producing states are Maharashtra, Karnataka, Madhya Pradesh, Bihar, Gujarat, Rajasthan and Haryana, which together account for 70 percent of total production. It demonstrates that onion production in India is steadily increasing. But there is using traditional onion harvesting method which is more time consuming and more labor required. And now a day there is big labor shortage issue in this field.

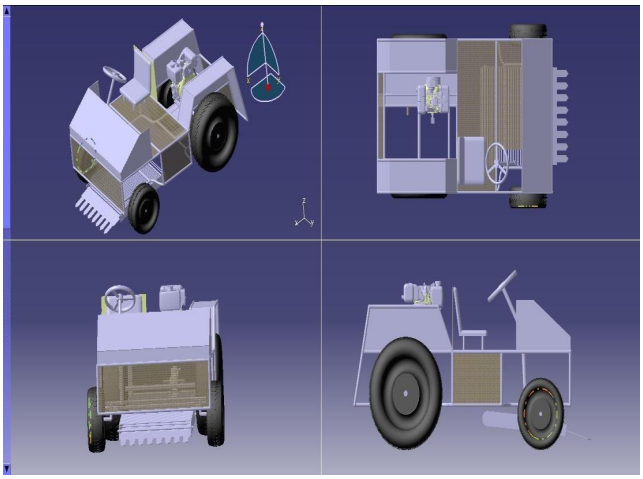

Fig 1.1Cad model of Onion Harvester

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In India, particularly in Maharashtra and Gujarat, small farms are used to produce onions, and large onion harvesting machines are available are not useful and costly. So overcome this problem we try to design and manufacture automated onion harvesting machine working on diesel engine with self started India ranks second in global onion production after China and with an annual production of 18 to 20 million tones accounts for around 25% of global production. However, Indian onion yield is one of the lowest. Wide price fluctuations make it a risky crop discouraging large scale adoption of input intensive production techniques and good management practices by farmer.

A mechanical single row harvester consisting of picking mechanism, digging mechanism, conveying mechanism and separate mechanism. Tractor drawn elevator type potato diggers are available in India but separate self propelled mechanical onion harvester is not use in India. The field conditions and biometric properties of the onion crop are completely different from those of the potato crop. Thus, potato digger could not be used for onion digging, directly. Limited information is available on soil- machine crop parameters influencing the design of various machine components of an onion digger. The proposed onion harvester is designed to lift the lodged crop, dig the bulbs, lifting the bulbs and separating of soil, and windrowing the crops for later collection of bulbs from the field. It is therefore, proposed to study various soil-machine crop parameters relevant to design of onion digger and finally design and develop self propelled mechanical onion harvester .

CONCEPT

The full onion harvesting machine works on the principle of conversion of human applied force into the mechanical energy. 2 bevel gears are attached to the shaft on wheel and pulleys also attached on perpendicular shaft. When operator push the machine wheel shaft start rotate and bevel also start rotate the relative motion of bevel start pulley rotatebecause of that belt also start rotate.

The developed onion harvesting consisted of a feed wheel shaft, chain sprocket, pulley, belt, cutter and container. The performance of the onion harvester was evaluated at different level of combinations of the study variables namely, wheel speed, force onstructure, depth of the onion, soil state, tension in belt, Blade sharpness. Based on the findings, optimal study variable values for the prototype onion harvester were recommended based on harvesting efficiency, harvested and remaining onion, damage, and energy requirement. The performance of the prototype onion harvester with the recommended specifications was evaluated.

Problem Identification of onion harvester-

Traditional onion harvesting process is time consuming.

In this process first onion pulled up by hand manually gather them latter cut its steam by using blades.

In this process more time and more man power require but now a day there is shortage of man power.

By another method there is use huge machine use for onion harvesting but it is noteconomical for small fields.

Problem Formulation Considering the above problems, it is necessity to design, develop and fabricate such a machine that will eliminate most of the problems. To reduce the human fatigue, cost and time the design and fabrication of machine is important.

5. Seasonable change in soil and easy machine harvesting.

Objectives of Onion Harvester-

To reduce human effort.

To increase the capacity of onion harvesting 3) To increase theefficiency of onion harvesting.

To reduce the cost and time of onion harvesting.

To design a onion harvesting machine for setting up small scale, 6) Low costrural industry.

So minimize the cost of farmer of onion harvesting. After identifying small-scale, low-cost onion harvesting

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machines, the machines' performance will be evaluated for commercial applications. If performance is found satisfactory, the machines would be usedfor commercial applications.

Fig.2.2: Earlier Work of Onion Harvester

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Methodology:
Stage1: Data Collection
Data collection phase involves the collection of reference material for the project. The methodology for the project work and the collection of research paper regarding the project topic.

Stage 2: System Design
The system design consisting of development of the mechanism so that the project can perform the desired operation.

Stage 3: Design and Validation
The parts listed in the part list will be designed using the given system of forces, and the appropriate dimensions will be calculated. The standard part will be chosen from the design manual.
Stage 4: Production Drawing Preparation
Production drawings of the parts are prepared using CAD software, CATIA with appropriatedimensions.

Stage 5: Material Selection and Process Development Materials are chosen based on their dimensions and properties. Part process planning is done to determine the manufacturing process and the appropriate machine for the same.
Stage 6 Manufacturing Parts Assemblage Parts are manufactured in accordance with the parts drawing. The machine is assembled according to the assembly drawing, and a trial run on the project device is performed to evaluate performance.
Stage 7: Report Preparation
Report preparation activity is carried out during the above phases.

DESIGN OF COMPONENTS

3.1 Digging System

The digger blade is an important component of the onion digger. Design and selection of the blade considerably affect the draft and damage of the crop. Shape of digger blade is an important factor in order to reduce draft of digging and essay collection of dug materials. In conventional practice, the onion bulbs are harvested by pulling them along with leaf from soil and the tops are cut by a sickle or khurpi. The harvesting at maturity stage of onion is a very important factor for deciding the storage life of onion. The design parameters of the onion digger and potato digger were reviewed to get the range of the value. This would help in selecting the parameter of conceived self propelled onion digger.

Design of blade MS flat was taken having shear stress and 150 kg/cm2 and 450 kg/cm2 respectively. To overcome the problem of bending and breaking concave used for onion harvesting, a mild steel flat with a thickness of 10 mm was used. According to the power requirement calculation, the overall working width and depth of operation for the cutting blade are 60 cm and 10 cm, respectively. At a field capacity of 0.46 ha/h, the digger was operated at a speed of 4 km/h in first high gear with minimal losses. The depth control arrangement worked well for controlling the depth of cut by the blade. The developed digger's average operational depth of 7.62 cm was suitable, with almost no damage to the onion bulbs. The digger's operational time, including and excluding turning time, was 3.10 h/ha and 2.38 h/ha, respectively.

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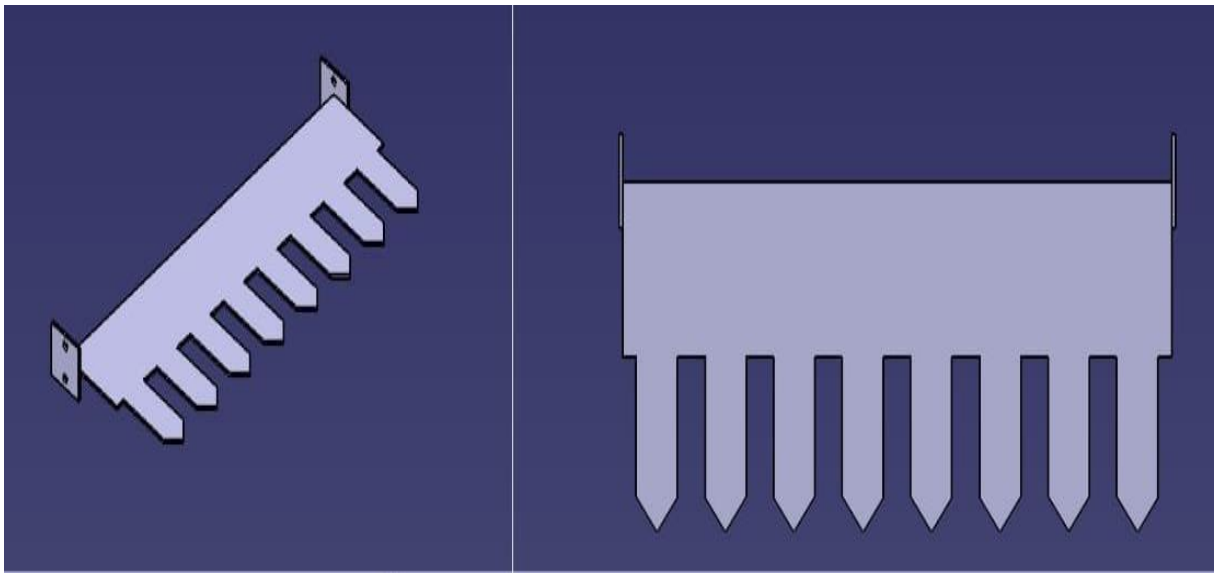

Fig 3.1: Digging Blade

Fig 3.2: Actual Machine

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Table 3.1: The Overall Calculations of the Digging Blade:

Blade Geometry	Width	800 mm
	Thickness	10 mm
	Length	300 mm
	Type of Teeth	V- Arrowtype
	Angle of Teeth	45 Degree(Long)
Design of Blade	Depth to Width Ratio is greaterthan 1 is called narrow type.	Depth to Width Ratio is greaterthan 1 is called narrow type.
	Depth to Width ratio is less than 0.5 is called blade.	Depth to Width ratio is less than 0.5 is called blade.
Harvesting Calculations	Shear Blade Rake Angle	18 Degree
	Width Of Harvesting	800 mm
	Depth Of Harvesting	80 mm
	Shear Blade Rake Angle	18-24 Degree Adjustable
Draft Calculations	Passive Resistance	145.82 kg/m
	Soil Resistance	0.07 kg/cm^2
Throat Clearance	550 mm	
Volume Of Soil	0.016 m^3/sec	

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Bending moment of blade :-

Fx = -wx (Minus sign due to rightdownward).
Where, w = load on theblade X = length of blade

Bending Moment at this Section calculatedby Mx= -wx/2
(Minus sign due to hogging)

We know that shear force at any section X, at a distancex from B,
Fx = -wx (Minus sign due to right downward)

Where,
W= load on the blade and web
X = total length of onion crop harvester

Soil reaction on the onion harvested blade:-

If θ is angle of inclination of force P in the vertical plane with the horizontal surface and φ is angle of inclination of P in the transverse plane with the horizontal direction.

$L = P \cos\theta \cos\varphi$ $V = P \sin\theta \cos\varphi$ $R = P \cos\varphi$

Where,

L = horizontal component (Kg)V = vertical component (Kg)
R = Resultant force (Kg)P = pulling force (kg)
Chassis with FEA analysis

The frame, also known as the chassis, is the main supporting structure of a motor vehicle to which all other components are attached, similar to an organism's skeleton. Almost all trucks, buses, and pickups still use a separate frame as their chassis.
The primary functions of a frame in a motor vehicle are as follows:
To support the vehicle's mechanical components and body
To deal with static and dynamic loads, without undue deflection or distortion.These include:
Weight of the body, digging, and cargo loads.
Vertical and torsional twisting transmitted by going over uneven surfaces.
Transverse lateral forces caused by road conditions, side wind, and steering thevehicle.
Torque from the engine and transmission.
Longitudinal tensile forces from starting and acceleration, as well ascompression from braking.
Sudden impacts from collisions.

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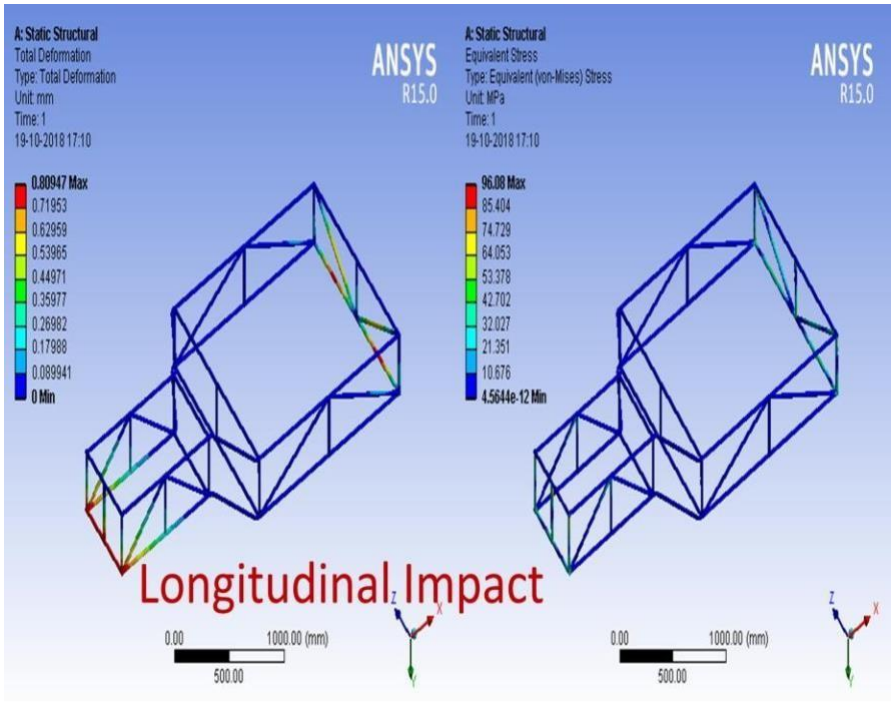
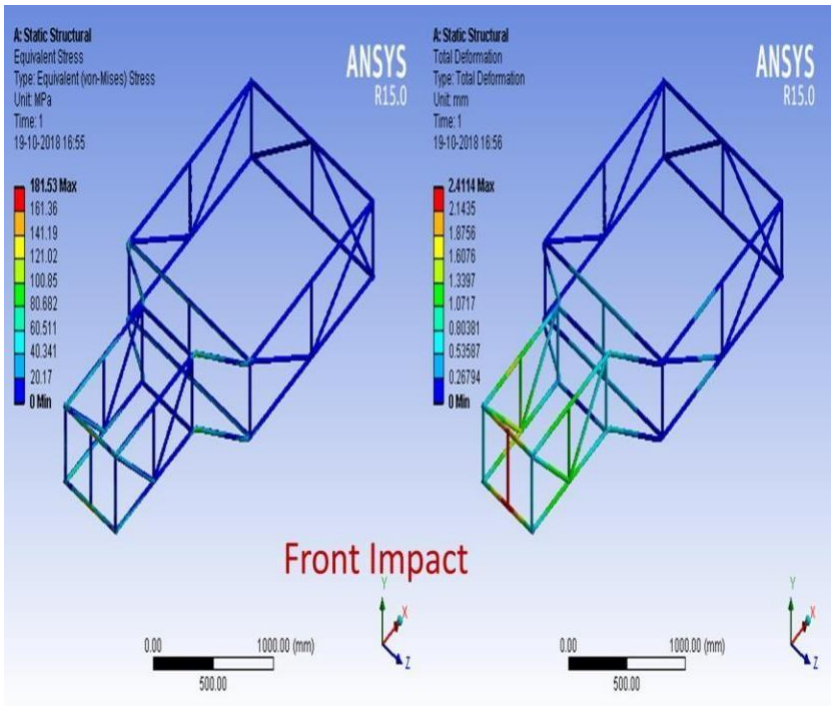
Mild steel is steel with a carbon content ranging from 0.12 to 2.0 percent as the main interstitial alloying constituent. The American Iron and Steel Institute (AISI) definition says: Steel is considered to be carbon steel when no minimum content is specified or required for chromium, cobalt, molybdenum, nickel, niobium, titanium, tungsten, vanadium or zirconium, or any other element to be added to obtain a desired alloying effect; when the specified minimum for copper does not exceed 0.40 percent; or when the maximum specified content for any of the following elements does not exceed the percentages noted: manganese 1.65, silicon 0.60, copper 0.60. The term "carbon steel" can also refer to steel that is not stainless steel.





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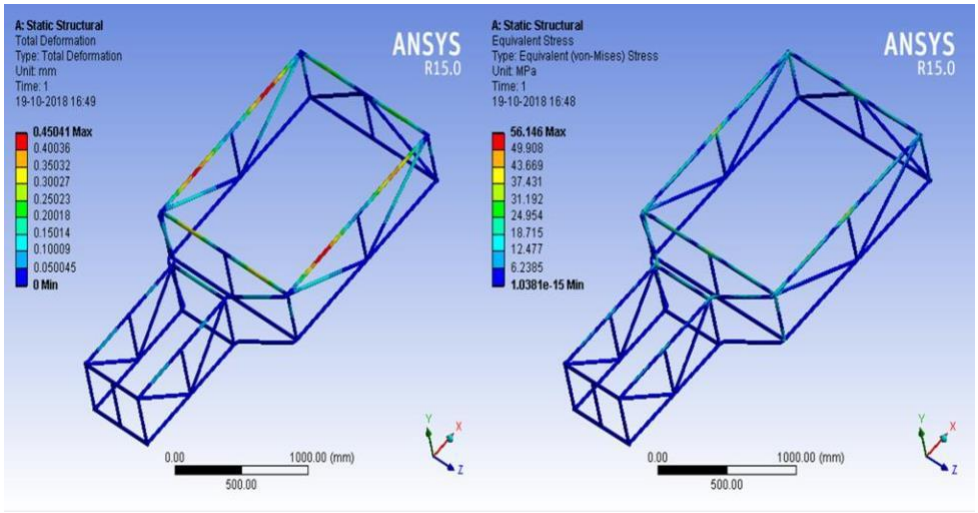
As the carbon percentage content rises, steel has the ability to become harder and stronger through heat treating; however, it becomes less ductile. Regardless of the heat treatment, higher carbon content reduces weld ability. In carbon steels, the higher carbon content lowers the melting point.



Vertical Impact

Key feature:
Compact
Portable
Reduce time consumption
Eco friendly
Less energy consumption
Cost effective
Less maintenance required
Risk free and easy to use

Table 4.1: Overall Dimensions

Overall Dimensions	Length	2200 mm
	Width	1350 mm
	Height	1120 mm
	Max. Track Width	1150 mm
	Wheel Base	1450 mm
	Machine Kerb Weight	412 kg
	Wheel & chassis Clearance	320 mm

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Table 4.2: Material Properties

Material	AISI 1020
Carbon	0.18 - 0.230 %
Yield Tensile Strength	295 MPa
Ultimate Tensile Strength	395 MPa

Steering system

The steering system converts the rotation of the steering wheel into a swiveling movement of the road wheels in such a way that the steering-wheel rim turns a long way tomove the road wheels a short way. The system allows a driver to use only light forces to steer a heavy car. The rim of a 15 in. (380 mm) steering wheel moves nearly 16 ft (5 m) in four turns from full left lock to full right lock, while the edge of a road wheel moves only slightly more than 12 in (300 mm). The driver would have to push nearly 16 times harder if he or she swivelled the road wheel directly.

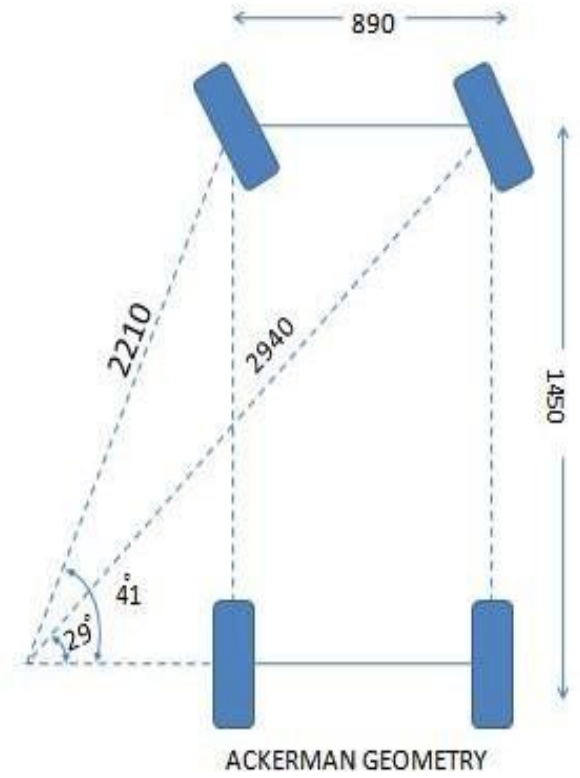

Fig 5.1 Steering system

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The steering effort is transferred to the wheels via a system of pivoted joints. These are intended to allow the wheels to move up and down with the suspension while maintaining the steering angle. They also ensure that the inner front wheel, which must travel around a tighter curve than the outer one, becomes more sharply angled when cornering. The joints must be precisely adjusted, and even a slight looseness causes the steering to be dangerously sloppy and inaccurate. A small pinion (gear wheel) is housed inside a housing at the base of the steering column. Its teeth interlock with a straight row of teeth on a rack, which is a long transverse bar. The rack moves from side to side as the pinion is turned. Track rods connect the rack's ends to the road wheels. Because this system is simple, with few moving parts that can wear out or become displaced, its action is precise. The steering column has a universal joint that allows it to connect to the rack without angling the steering wheel awkwardly sideways.

A worm gear inside a box is located at the base of the steering column. A worm is a short bolt-like threaded cylinder. Consider turning a bolt with a nut on it; the nut will move along the bolt. Similarly, turning the worm moves anything that fits into its thread. Depending on the design, the moving part could be a sector (like a slice of a gear wheel), a peg or a roller connected to a fork, or a combination of these. Alternatively, a large nut. The worm moves the drop arm via a peg connected to a fork in worm-and-peg steering. Hardened balls run inside the thread between the worm and the nut in the nut system. The balls roll out into a tube that transports them back to the start as the nut moves; this is known as a recirculating-ball system. The worm moves a drop arm connected to a steering arm that moves the nearest front wheel via a track rod. The thread between the worm and the nut is filled with balls or a roller connected to a fork or a large nut in recirculating-ball steering. The worm moves the drop arm via a peg connected to a fork in worm-and-peg steering. Hardened balls run inside the thread between the worm and the nut in the nut system. The balls roll out into a tube that transports them back to the start as the nut moves; this is known as a recirculating-ball system. The worm moves a drop arm connected to a steering arm that moves the nearest front wheel via a track rod. The thread between the worm and the nut is filled with balls in recirculating-ball steering.

5.1 Design of Hub

Outer 5 hole of diameter 20mm each and pitch circle diameter of160 mm Inner 3 hole of diameter 10 mm and Pitch circle diameter of 107mm Material of hub is EN8

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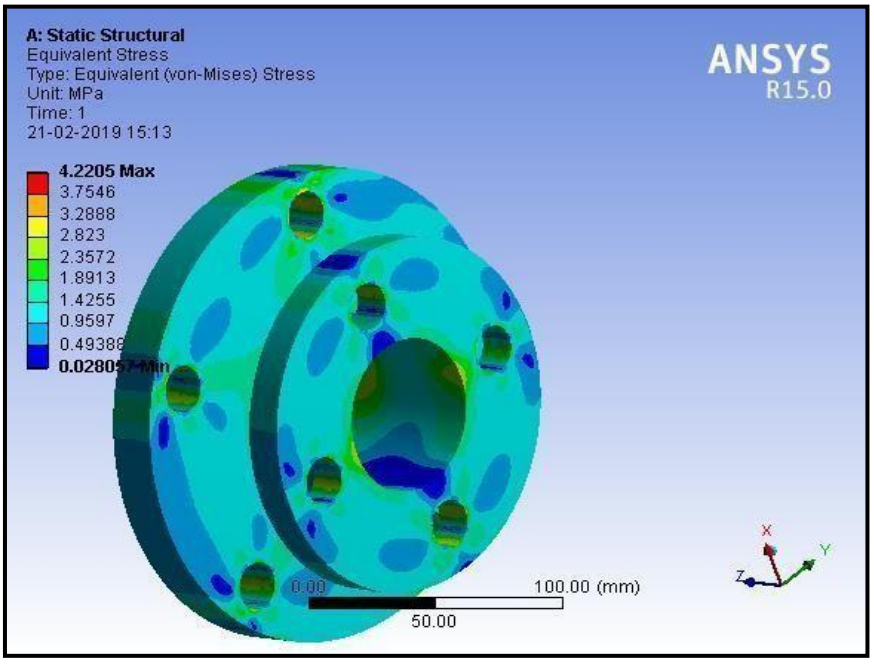

Fig 5.1.1: Ansys of hub

Conveying System

The elevator/ conveyor of the digger perform the operations such as conveying the materials
i.e. soil with onion to the windrower at the same time it separate soil from the onion bulbswith leaves.
The spacing between web rods, slope and speed of the elevator effects performance of the digger. The information on elevator was reviewed and presented. The maximum separating index was observed for 1.5 m length of conveyor for all combination of speed ratio and slope.

To determine position of bulb with respect to ground surface, the quantity of the material to be handled by the digger for separation, and throat height of the digger the following measurement taken.

Number and length of leaves per onion bulb
Depth of bulb below the ground level
Diameter of the onion bulb
Height of onion bulb

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Table 6.1: Separating System

Chain Drive	length	600 mm
	width	800 mm
	Outer Dia. Of Sprocket	100 mm
	Diameter of Pitch Circle	94.92 mm
	Diameter of chain Roller	6.35 mm
	Pitch Circle	9.525 mm
	No. of Teeth	12
	total number of rod	18
	Chain Links	36
Speed Calculations	Velocity	0.9 m/s
	Revolutions per Minute	70
Cleaning &Spacing Unit	Diameter of Rod	8 mm
	Spacing	25 mm

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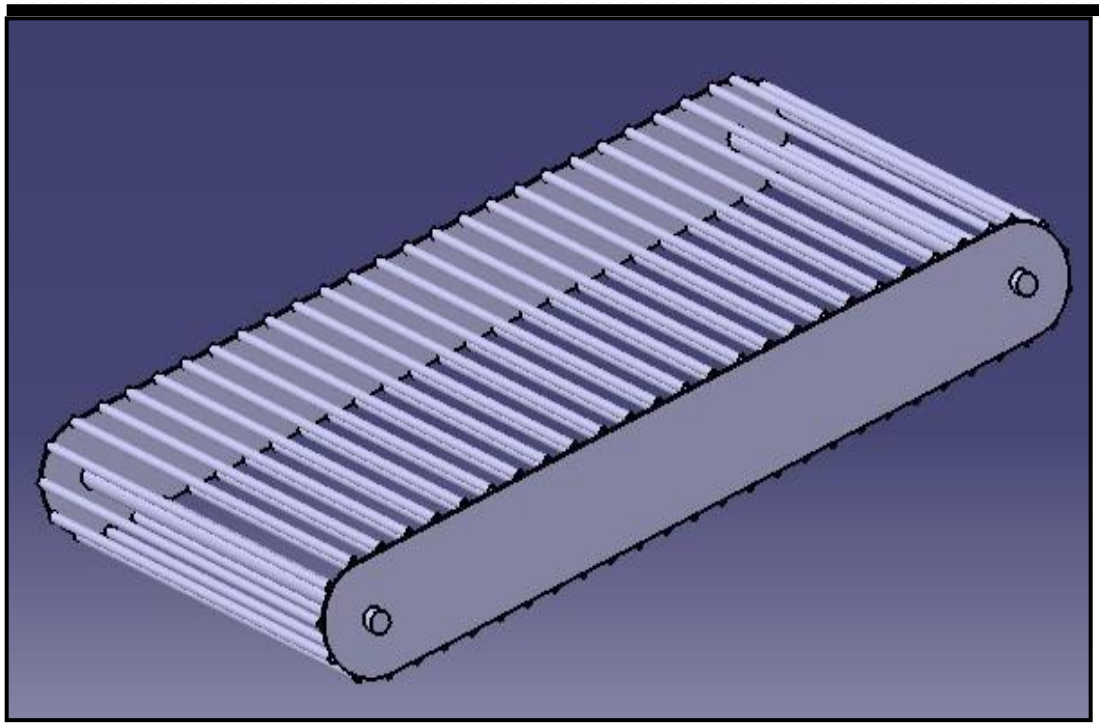

Fig 6.1: Conveying System

Power Consumption = 1.06 kW

Material Handling Capacity= 0.0388 m3/sec

Crop Pattern

Onion will be planted in 5 rows on each bed at 0.15m apart. (Row to row spacing)

Onion will be planted 0.10 m apart in each row. (bulb to bulb spacing)

Size of onion will be 3 to 6.5 cm. (Diameter)

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Approximate weight of onion 70-80 gm per bulb.

The maximum length of leaves ranges from 60 to 65 cm - partially lodged from neckof onion bulb.

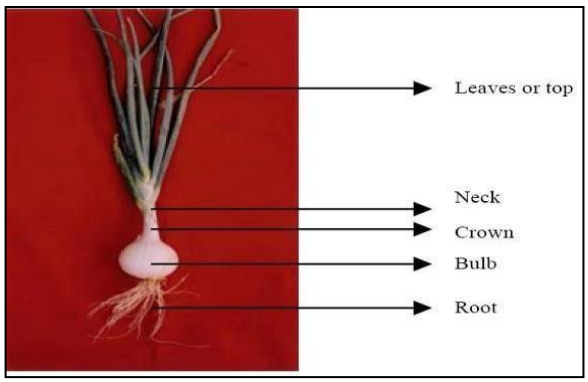

Fig 6.1.1: Overall structure of onion

Transmission System

The mechanism that transmits the power developed by the engine of automobile to the engine to the driving wheels is called the TRANSMISSION. It is composed of
Clutch
The gear box
Front axle
Tyres

A transmission is a machine in a power transmission system that provides controlled power application. The term transmission is frequently used to refer to the gearbox, which uses gears and gear trains to convert speed and torque from a rotating power source to another device. The transmission is most commonly used in automobiles, where it adapts the output of the internal combustion engine to the drive wheels. Such engines require a relatively high rotational speed, which is inconvenient for starting, stopping, and slower travel. The transmission converts the higher engine speed to the slower wheel speed, increasing torque. Transmissions are also used on pedal bicycles, fixed machines, and other applications that require different rotational speeds and torques.

The machine was composed of three major components: digging, separating, and power transmission units. Because internal combustion engines cannot run below a certain speed, transmissions in automobiles are typically connected to the engine crankshaft via a flywheel, clutch, or fluid coupling. The transmission's output is routed through the driveshaft to one or more differentials, which drive the wheels. While a differential can provide gear reduction, its primary function is to allow the wheels at either end of an axle to rotate at different speeds (essential to avoid wheel slippage on turns) while changing the direction of rotation

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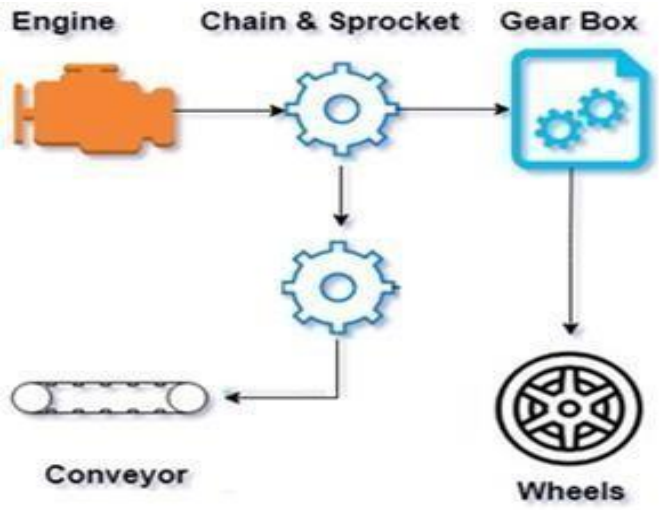

Fig 7.1: Transmission System

Gear Selection	Gear Ratio	Vehicle Speed
1st	5.27	2.27
2nd	2.59	4.54
3rd	1.6	7.51
4th	1	12
Reverse	4.51	2.68

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raking system

A brake is a mechanical device that prevents motion by absorbing the energy of a moving system. It is used to slow or stop a moving vehicle, wheel, axle, or to prevent its motion, most commonly through friction.
Many types of brakes are available in the market for modern vehicles, but we can use a disc brake because of. The disc brake has its own set of advantages, one of which is the ease with which it can be inspected. This brake system is also more powerful than a drum brake. Disc brakes are completely self-adjusting, and because this type of brake is so popular, there is a large selection of disc brake pads to choose from. For those who want to upgrade from drum brakes to the more efficient disc system, disc brake conversion kits are available. Disc brakes are a type of brake system that works by squeezing an attached metal disc in a vise-like hydraulic calliper to slow the rotation of the wheel. On the front wheels, we had to use disc brakes.

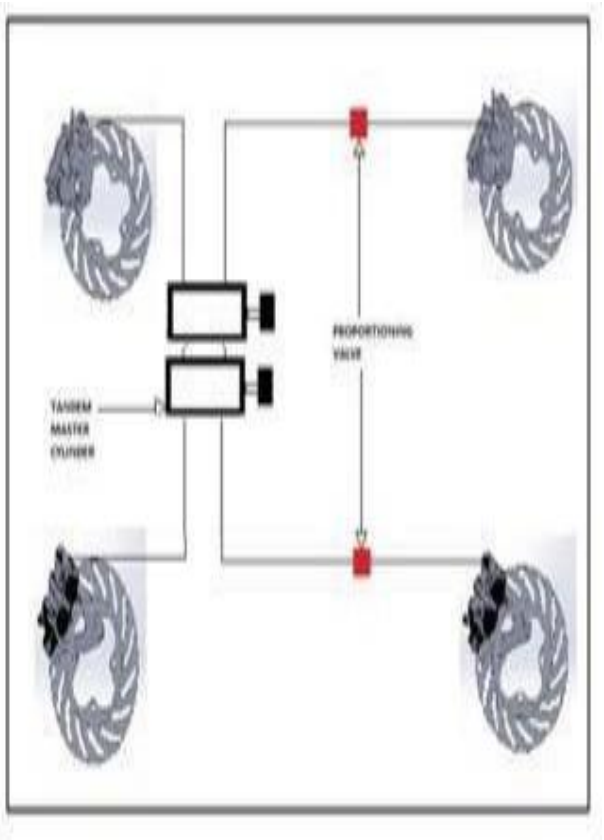

Fig 8.1: Braking System.

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BRAKE CIRCUIT	
Circuit Type	F/R Split
Disc Diameter (OEM)	160 mm (Front)
Brake Fluid	DOT 3
Caliper Pads	2
Master CylinderPressure	4.37 MPa
Braking Force	1120 N

Table .8.1: BRAKING CALCULATIONS

A hydraulic brake circuit consists of pipes connecting fluid-filled master and slave cylinders. When the pedal is depressed, the master cylinder sends hydraulic pressure to the slave cylinder. When you press the brake pedal, a piston in the master cylinder is depressed, forcing fluid along the pipe.

The fluid fills slave cylinders at each wheel, forcing pistons out to apply the brakes. Fluid pressure is distributed evenly throughout the system. The combined surface 'pushing' area of all slave pistons is much larger than that of the master cylinder piston. As a result, the master piston must travel several inches in order to move the slave pistons the fraction of an inch required to apply the brakes. This arrangement allows the brakes to exert significant force, similar to how a long-handled lever can easily lift a heavy object a short distance. A disc brake has a rotating disc that moves with the wheel. The disc is straddled by a calliper, which contains small hydraulic pistons powered by master cylinder pressure. To slow or stop the disc, the pistons press on friction pads that clamp against it from both sides. The pads are designed to cover a large area of the disc. In dual-circuit brakes, there may be more than one pair of pistons. When the brakes are applied, the pistons move only a fraction of a millimetre, and the pads barely clear the disc when the brakes are released. They don't have any return springs.

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When you apply the brake, fluid pressure forces the pads against the disc. Both pads barely clear the disc when the brake is turned off. Rubber sealing rings around the pistons are designed to allow the pistons to gradually slip forward as the pads wear down, ensuring that the tiny gap remains constant and the brakes do not need to be adjusted.

Windrowing System

Harvesting, handling, and storing fresh vegetables with low dry matter is a significant challenge for large growers. They must invest significant time and money in order to find the best solution at the lowest possible cost and with the least amount of damage possible with mechanical harvesting. Due to labour shortages, the table onion, which accounts for more than 90% of the Middle Eastern market, is increasingly being harvested by machines.

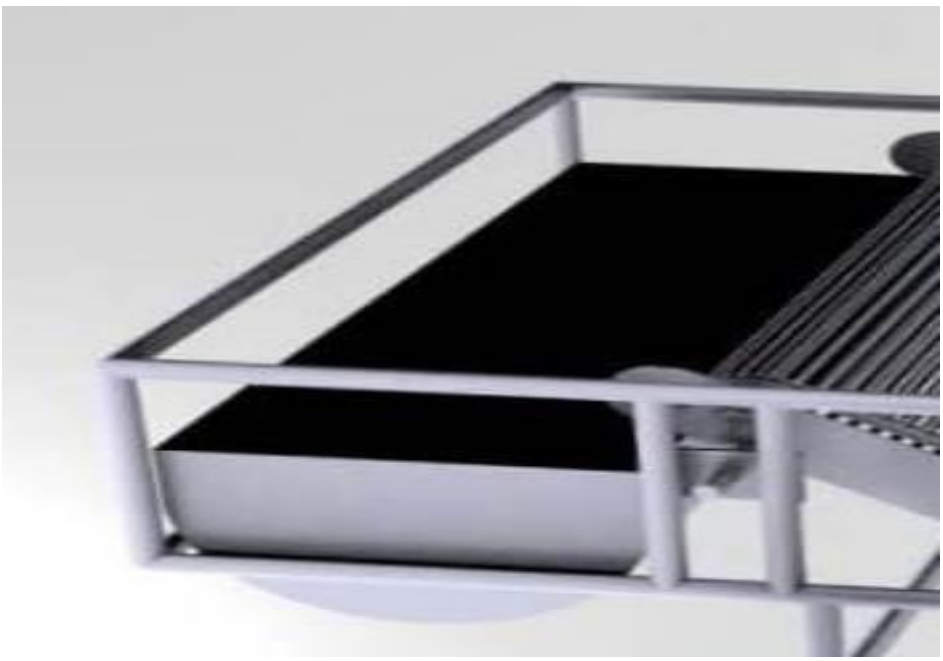

Fig.9.1

INNOVATION.

Roof top canopies is provided with solar panel assembly mountings.
It will take care of driver from weather conditions.
It will help to prevent driver in roll over.
It will help to recharge batteries during working hour or in stationarycondition.

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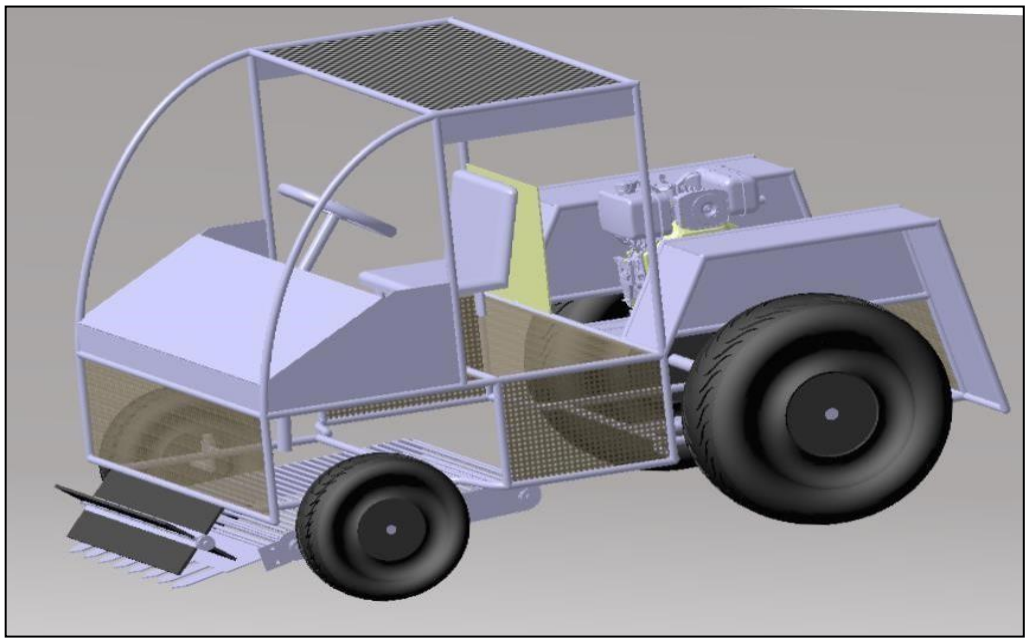
help to recharge batteries during working hour or in stationary condition

Battery Specification	
Company	Amaron
Model	BL600RMF
Volt & Current	12 V & 60 AH



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- Battery wattage = A* V = 60 * 12 = 720
- Average sunlight in day = 6 hrs
- Need of solar panel for charge = 720 wattage battery in 6 hrs
- Solar Panel selection = Battery wattage / Average sunlight in day. = 720/6 = 120 watt.
- Consider 25 % losses = 120 * 1.25 =150 watt
- Finally we have selected 150 watt solar panel.

Battery

Solar Plate

Solar S	**pecification**
Company, model	Waree (Arun)
Type	Polycrystalline
Voltage & Current	12 V & 7.2 A
Watt	150

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CONCLUSION

In this project we have proposed a self propelled onion harvester. In conventional way of onion harvesting we require more cost and manpower comparatively & this method is fully based on the work of human effort hence more time consuming so it requires more workers. Here we invented a machine which will minimize that cost and time for removal ofonion. Also we succeed to make it affordable to all farmers and it increases the speed of work so our objective is fulfilled in this project.

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