iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 12 **Issue:** V **Month of publication:** May 2024

DOI: https://doi.org/10.22214/ijraset.2024.61966

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue V May 2024- Available at www.ijraset.com

Design and Development of Soil Drilling Machine for Plants - Approach

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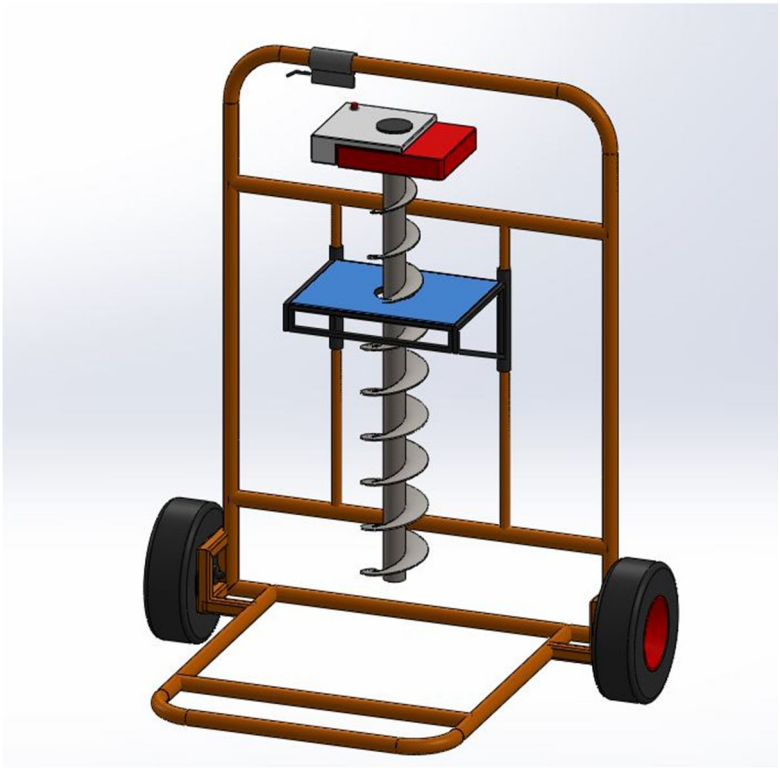
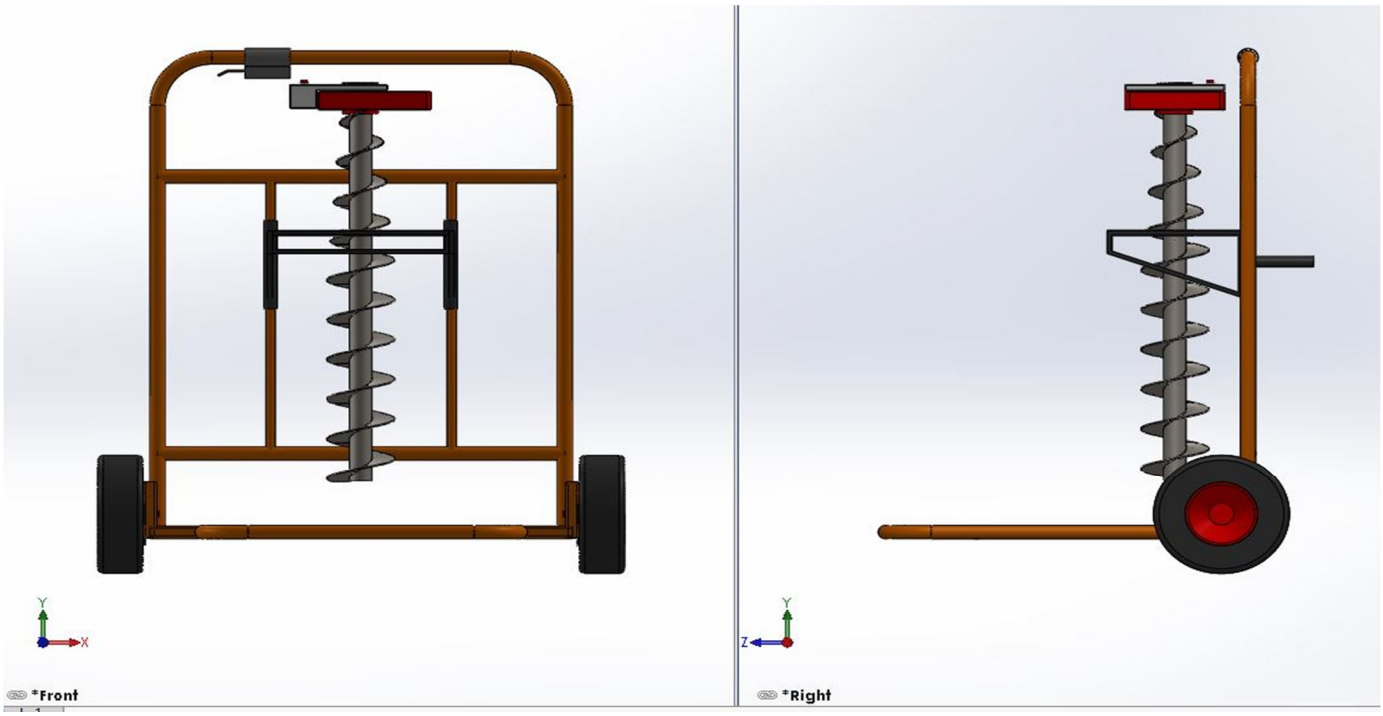
I. INTRODUCTION

The interest of people towards the plantation of saplings is increasing due to global warming, the rise in global temperature, and many such factors, so plantation is being done at a faster rate through many of the N.G.O' S as well as people. In the case of planting saplings in a huge number, it is difficult to use levers, and hand link mechanisms for the same it makes the process harder and takes a very long time. Here the main purpose of this project is to reduce the digging time. This machine is designed with a preliminary aim of avoiding the use of shovels & axes in the plantation of saplings thereby enhancing the plantation process. The machine is formed automatically by employing a D.C motor which is an influence source for digging the soil. The greater advantage of this machine is that it digs only the required area and also does the same in very minimum time. This makes the auger drill a hole in the soil and return to its original position. This machine is meant for a preliminary aim of avoiding the utilization of shovels & levers in the plantation of saplings thereby enhancing the plantation process by making it facile. Soil drilling machines can cover vast areas efficiently, allowing for the rapid establishment of green cover. Whether it's reforestation, afforestation, or urban tree planting, these machines enhance our ability to combat environmental degradation. The conventional Soil Drilling Machine does not have any frame around the body. We have provided a frame around the body which will not only provide strength to the model but also will make it easy to operate even by a single operator. By considering safety factors during fabrication, the provided frame will minimize risks of equipment malfunction, and injuries while working on a soil drilling machine. The frame will also reduce the vibrations that are produced while working on the auger.

II. DESIGN





III. MATERIAL SELECTION

Mild Steel AISI 1018 is a common type of mild steel, also known as low-carbon steel. Mild Steel AISI 1018 contains Iron, manganese, phosphorus, and Sulfur as strengthening agents. It is one of the most widely used grades of steel due to its relatively low cost, ease of machining, weldability, and versatility in various applications. AISI 1018 has moderate strength compared to other grades of steel. It is not particularly high in strength but provides adequate toughness for many applications. One of its notable features is its excellent machinability, making it easy to work with using various machining processes such as drilling, milling, turning, and tapping. AISI 1018 can be welded easily through common welding methods like MIG and TIG welding.

Properties	Mild Steel 1018	
Tensile strength, ultimate	440 MPa	63800 psi
Tensile strength, yield	370 MPa	53700 psi
Modulus of elasticity	250GPa	29700 ksi
Bulk modulus (Typical for steel)	140 GPa	20300 ksi
Shear modulus (Typical for steel)	80 GPa	11600 ksi
Poisson's ratio	0.290	0.290
Elongation at break (in 50 mm)	15.0%	15.0%
Reduction of area	40.0%	40.0%
Hardness, Brinell	126	126
Machinability (Based on 100% machinability for AISI 1212 steel.)	70 %	70 %
Thermal conductivity (100°C)	51.9W/mK	360BTU in/hr.ft^2. °F
Density	7.87 g/cc	0.284lb/m^3

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IV. ENGINE

An Earth auger with a 68 cc engine typically refers to a power tool used for drilling holes in the ground, usually for tasks like planting trees, installing fences, or setting posts. The "68 cc" refers to the engine displacement, which is a measure of the total volume of air and fuel that can be combusted in the engine's cylinders. A larger engine displacement generally indicates more power and torque, which can be beneficial when drilling through tough or compacted soil. These augers usually consist of a motor or engine, a shaft, and a drilling bit or auger attachment. The engine powers the rotation of the auger bit, allowing it to penetrate the ground efficiently.

Class	Standard
Engine	68cc , 1-cylinder, 2-stroke, air-cooled
Fuel Type	Petrol
Oil Mixing Ratio	01:25
Top Speed	8000rpm
Power	1.9kw/6500rpm
Fuel Tank Capacity	1200ml
Gear Ratio	32:1
Drilling Rotational speed	170U/Min
Gross Weight	17Kg
Net Weight	14Kg
Dimensions	25x30x45 cm
Carburetor	Diaphragm type

V. CALCULATIONS

For Capacity:

The Calculations for an earth auger typically involve determining the volumetric flow rate or throughput of the auger, which is the rate at which material passes through the auger. This is usually measured in cubic inches per minute or cubic meters per hour.

The formula used:

Here:

$$\text{Capacity} = \pi * (\frac{D^2}{4}) * R * N$$

$$\text{Capacity} = \pi * \left(\frac{8^2}{4}\right) * 2.5 * 8000$$

$$\text{Capacity} = 1005309.65 \text{ (cubic inches per minute)}$$

Capacity refers to the volumetric flow rate

D is the diameter of the auger

R is the pitch of the auger flight

N is the rotational speed of the auger

All measurements for D and R are in the inches and N in revolutions per minute (RPM).

For Torque:

we have an auger with a diameter of 0.2 meters (or 20.32 cm), and it is rotating at a speed of 8000 RPM. The power required by the auger is 1.9 kW or (1900watts). First, we need to convert the speed from RPM to radians per second. We know that 1 RPM equals approximately 0.1047 radians per second. So, 8000 RPM would be approximately 837.6 radians per second.

We can use the formula:

$$P=\omega \times T$$

Where:

- P is the power,
- ω is the speed in radians per second, and
- T is the torque.

.Now, we can rearrange the formula to solve for T:

$$T = \frac{P}{\omega}$$

$$T = \frac{1900}{837.6}$$

$$T = 2.269Nm$$

So, the torque required by the auger is approximately 2.269 Nm.

For Shear stress:

The shear stress on an earth auger drill bit can be calculated using the principles of mechanics and material science. The shear stress (τ) is typically calculated using the formula:

$$\tau = \frac{F}{A}$$

Where:

F is the force applied parallel to the surface of the material, and

A is the area over which the force is distributed.

In the context of an earth auger, the force F would be the force exerted by the soil on the drill bit, and the area A would be the cross-sectional area of the drill bit.

However, the actual calculation can be quite complex as it depends on various factors such as the hardness of the ground, the diameter of the auger, the angular velocity, the pitch of the blade, and the amount of force being applied to push it in.

A 300 mm diameter auger drill for agricultural works and analyzed in Autodesk Inventor software with the help of Nastran in a computer-aided design (CAD) module. According to the analysis, Von Misses stress analysis result was found a maximum of 2266 MPa and a minimum of 0 MPa.

VI. RESULTS

1) The torque required by the auger is approximately 2.269 Nm.
2) The capacity of an earth auger is typically 1005309.65 (cubic inches per minute).
3) For a 300mm diameter auger drill, Von Misses stress analysis result was found as a maximum of 2266 MPa and a minimum of 0 MPa.

VII. CONCLUSION

The following modifications are done while redeveloping the earth auger.

1) This modified model is more efficient and comfortable to operate.
2) The machine can be used by a person in less time compared to traditional methods, so if we manufacture it on a large scale its cost gets significantly reduced.
3) Ease in transportation Easy transportation of developed Earth Auger in the field, stability during operation- For minimizing vibrations supporting frame or trolley and wheel of rubber were provided. So that during operation they would support the machine, maintain the stability, and minimize vibrations.
4) Safety of operator – Improvements to ensure operators' safety are installed in the modified Earth auger, such as a frame for increased stability during drilling, etc.

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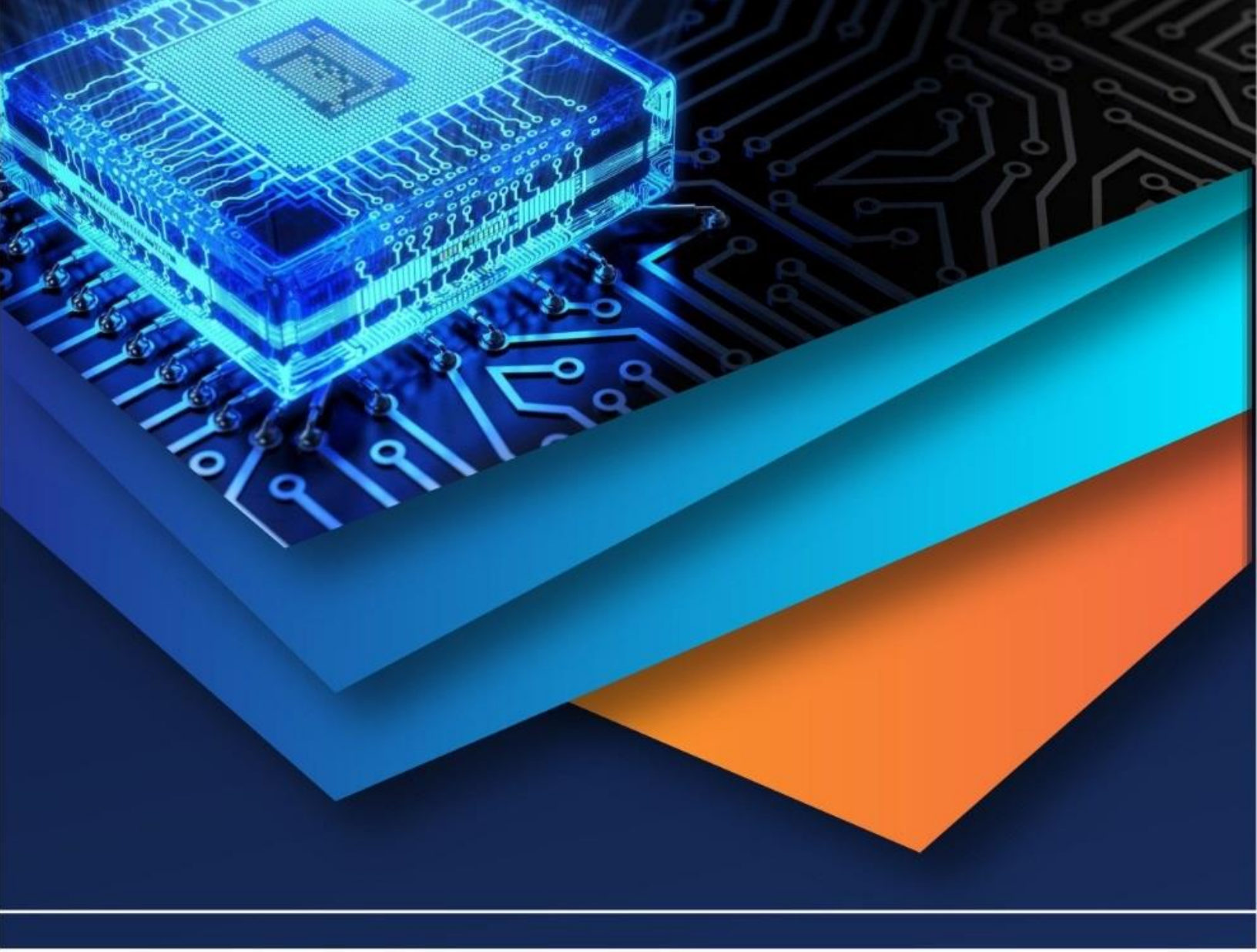

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