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# 360 DEGREE DRILLING MACHINE

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**Abstract -** *Nowadays, the drilling machine is a rapid growth product with more uses and applications. Drilling machines are used to make the holes on the given workpiece. The Basic Drilling Machine efforts more constraints by limiting their movements and direction. There is a severe problem between drill and job which provides less space to make the holes. In this project, we are working on a 360-degree drilling machine to eradicate the problems by moving the drill in different locations. The precision and accuracy are higher in this Machine because the setup provides the proper straightness to the drill bit . This makes efficient holes on the workpiece rather than deformation in the drill bits. The 360 degree drill setup consists of different connecting arms which assists the movement of the drilling machine in horizontal, vertical and upside down direction which is mounted on a flat surface like a table provided with the swivel wheels. The caster locks are introduced to limit the movement of the drilling machine. The cost of manufacturing and setup is comparatively lower than other drilling machines. The feasibility of the project is expected to be good. The handling is easily done by the operator. This 360 degree drilling machine can be implemented to all the industries using drilling operations because of the selective axis and angle of drilling with the higher accuracy.*

***Key Words*: 360 degree ,Precision , Accuracy ,Portable , Drilling**

## 1.INTRODUCTION

Drilling is the process of using metal cutting tools to make holes in a workpiece. Trepanning, counter boring, reaming, and boring are all machining techniques that include drilling. All of these processes, when paired with a linear feed, have the same movement. Short hole and deep hole drilling are two separate types of drilling. The drilling process can be related to turning in several ways but the requirements for chip breaking and chip evacuation are increasing. In drilling, this is crucial. The hole dimensions, as well as the size of the hole, limit the amount of machining that may be done.The deeper the hole, it is more difficult to maintain process control. Along with quality, a high material removal rate is becoming increasingly important and dependable. The Aim of the project is to design and analyze the 360 Degree Drilling Machine which is more efficient than the conventional drilling machine. The main objective of the project is to drill holes horizontally, vertically and even upside down direction. It can be drilled in any axis and any degree with the help of connecting arms setup. Due to this setup, we can achieve more accuracy of drilling in the workpiece and eradicate the different needs of different drilling machines. Selection of material plays an important role which should withstand the force and vibrations caused by the drilling operations. The components which are going to be used in the drilling setup also resists the vibration and make the setup rigid to make the drilling accurate. The cost of handling and manufacturing cost is low compared to the conventional drilling machine. This drilling machine is not needed by skilled laborers as it is easy to handle and operate the drilling machine. The highlight of this drilling machine which is portable as it has its own swivel wheels which provides the motion to the table. Due to its minimal space occupancy and more efficiency it can be applicable to the industries using drilling operations. It has the advantage of a portable drilling machine, as it can be portable to the desired drilling location.

### 1.1 SCOPE OF OUR PROJECT

- To drill holes in engine heads, blocks, and cylindrical shells with extreme precision.
- Used in furniture making.
- Future Scope
    - It is used in industries.
    - It is used with automation for automatic drilling.
    - In the future it will be used in every field where drilling is required. ○ Also use this method of rotation of the arm in other machining operations.

Finally, complete content and organizational editing before formatting. Please take note of the following items when proofreading spelling and grammar:

### 1.2 NEED OF THE STUDY

Every industry has relied on drill machines to function. Drilling holes in parts, sheets, and structures is commonplace in industry. Drilling that is perfectly aligned and well-aligned necessitates the use of fixed and powerful drills. Due to the small distance between the drill bit and the drill bed, some sections cannot be drilled with

fixed drills. In such instances, we must utilize hand drills, yet hand drills have alignment issues during drilling.So we created a 360-degree drill that can be mounted on a table and used to drill holes horizontally, vertically, or even upside down. As a result, even difficult pieces and surfaces can be easily drilled. Thus, we design and build a tiny 360-degree drill for convenient drilling operations using rotating hinges and connectors, as well as a motor mount and supporting framework.

## 2. LITERATURE REVIEW

G. N. Rakate et al. [1], discussed the purpose of this work in 2016 to enhance the design and fabrication procedure of a Multiple Spindle Drilling Head in order to reduce the part's cycle time. They create a model that can drill two holes at once and has a variable center distance between the two drilling spindles. Anandhan, P. Gunasekaran et al , [2] discussed the purpose of this work in 2016. The key goal is to be able to rotate the drill in any direction with ease. As a result, work setup will be less complicated and setup time will be reduced. This method might be regarded as the most efficient method for manually controlling the drilling machine. This technology can drill wood, soft synthetic material, and light metals with ease. Mr. Jay M. Patel et al.[3] discussed this purpose within the duration of 2015 to 2016 .It is based on a three-directional drilling machine that drills holes based on their location and movement. The operation can be completed with little effort, high precision, and accuracy thanks to this equipment. By minimizing total machining time, human labor, and manufacturing cycle time, this technology aids in increasing productivity. Lookesh kumar sahu, Pranesh kumar sahu et al. [4] discussed our purpose in the year 2018 . The author proposes a 360-degree drilling machine that can drill horizontally, vertically, or even upside down in this work. In this machine, a twist drill bit made of carbon steel is employed. Nandewalia Prajal et al.[5] discuss the purpose of the year 2018.The author investigates the Graphical Drilling Machine. In this study, they propose that the drill machine may drill graphically in any direction, with the drill rotating around two axes (x axis & z axis). These drilling machines used to drill wooden works and metals. The primary goal is to cut down on machine time and vibration. Prof. Ms. A.A. Shingavi, et al

## 3. MATERIALS AND METHODS

The material selection based on the application of the 360 Degree Drilling Machine, below are the requirements or the factors that influence the performance of the 360 Degree Drilling Machine and a wide study has been done before selecting the material.

### 3.1 PHYSICAL PROPERTIES

- High Wear resistance and cutting ability.
- Maintain high hardness upto temperature about 550°C and hence can be used for cutting metals and woods at high speed.

### 3.2 MECHANICAL PROPERTIES

- High Tensile Strength
- High fatigue strength
- High fracture toughness and impact strength to restrict quick fracture.

### 3.3 CORROSION RESISTANCE

- Low corrosion rate, this may increase the life of the 360 degree drilling machine.

### 3.4 EASE OF MANUFACTURING

- The usual drilling machine has the heavy metals, drill bed for the workpiece, complex locomotive mechanisms for the drill machine movements whereas the 360 degree drilling machine.
- Reasonable initial cost, low maintenance cost as it cannot be replaced or repaired often and low production cost. By considering the above factors, two materials selected for the study namely Mild Steel and High Speed Steel and their material properties are tabulated in the table 3.4.

**Table -3.4 :** *Mild Steel and High Speed Steel and their material properties*

| Properties | Mild Steel | High Speed Steel |
|---|---|---|
| Phase at STP | Solid | Solid |
| Density kg/m3 | 8000 | 78160 |
| Tensile Strength (Mpa) | 440 | 1200 |
| Yield Strength (MPa) | 250 | 1000 |
| Young's Modulus of Elasticity(GPa) | 370 | 200 |
| Brinell Hardness (BHN) | 200 | 720 |
| Melting Point (C) | 1510 | 1430 |
| Poisson's Ratio | 0.3 | 0.3 |
| Thermal Conductivity (W/m.K) | 15 | 41 |
| Heat Capacity (J/gK) | 460 | 470 |

## 4. DESIGN

The design process was completely carried out in Autodesk Fusion 360. The 3D Modeling of the

components of a 360 degree drilling machine is designed using Fusion 360. The dimensions of the components are visually calculated and implemented in the design. Then the kinematic movement of the 360 degree drill has been theoretically analyzed, the length of the arm is confirmed. The table, swivel wheels, Connecting Arms, Drill machine, Tightening clamps and drill stand have been designed.

### 4.1 DESIGN OF SWIVEL WHEELS

The swivel wheels have its own feature which is the basement and withstands the total weight on the top loads. Hence the proper swivel wheels are designed based on the terrains which are going to utilize and eradicate mounting applications. The caster lock is imparted into the swivel wheels to arrest the wheel movement. The design of the swivel wheel as shown in Fig 4.1 .

**Fig 4.1** *Design of swivel wheels*

### 4.2 DESIGN OF TABLE

The table of the 360 Degree Drilling machine has two complications. The top of the table payloads the complete setup of the drilling machine and the bottom has swivel wheels which should withstand the weight of the table and setup as shown in the *Fig* 4.2. The height of the table is fixed as it achieves the required height (90 cm). The table is light in weight because of the material Mild steel. The table withstands the vibrations caused by the drilling machine.

Fig 4.2 *Design of table*

### 4.3 DESIGN OF CONNECTING ARMS

The design of the connecting arm is the major part of the study as it should be light in weight and withstand heavy loads caused by the weight of the drill machine and the arms should be proportional for equal weight distribution. The connecting arm should not be deformed or cause any failure during the drilling operations. This may lead to the slippage of the drill bit and cause the non functioning holes in the workpiece. There are three connecting arms in this design. Each 450 cm which is suitable height for all the drilling applications. The hollow bars are appropriate for the connecting arms due to the advantage of resisting vibrations and lesser in weight than the solid bars. Each arm has its own purpose hence the certain changes done in Fig 4.3.

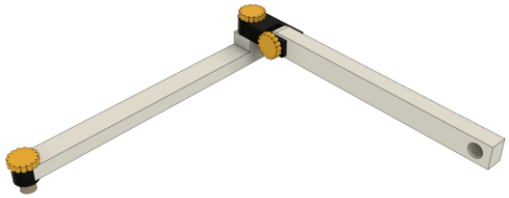

Fig 4.3 *Design of connecting arm link 1 and link 2*

### 4.4 DESIGN OF DRILLING CLAMP

The design of the drilling clamp is based on the convenience of the operator. We can use different portable drilling machines which can be clamped at the end of the connecting arms. The tightening clamp is adjusted by the tightening screws. The tightening clamp has the advantage of moving in two axis directions. For achieving higher efficiency, the holding bar is welded on the tightening clamps which is used to hold the drilling machine by the operator at the time of drilling operation .We designed a driller with clamp which is shown in the Fig 4.4.

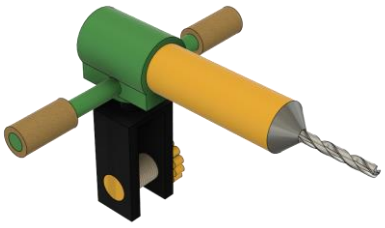

Fig 4.3 *Design of Drilling Clamp*

### 4.5 DESIGN OF DRILL BIT

The Brad point drill bit is going to be implemented on the drilling machine.Hence that drill bit is designed for the 360 Degree Drilling machine. The drill bits are based on the chuck capacity. We have already chosen the portable drilling machine and it's specifications. hence the 3mm

drill bit is implemented in the design which is shown in Fig 4.5.

Fig 4.5 *Design of Drill bit*

## 5. KINEMATIC MOVEMENT OF DRILLING MACHINE

The kinematic movements of the drilling machine as shown in Fig 5. is the essential part for the proper functioning of the drill setup. This study helped us for the proper dimensions impared in the connecting arms. This makes the drill setup easier to move and the arms do not collide themselves. The diagram shows the detailed movements of the connecting arms. The black circle indicates the horizontal rotation. There are three horizontal rotations. The yellow circle indicates the vertical rotation. There are two vertical rotations. Hence five rotational studies have been carried out to understand the proper movements of the 360 degree drilling machine.

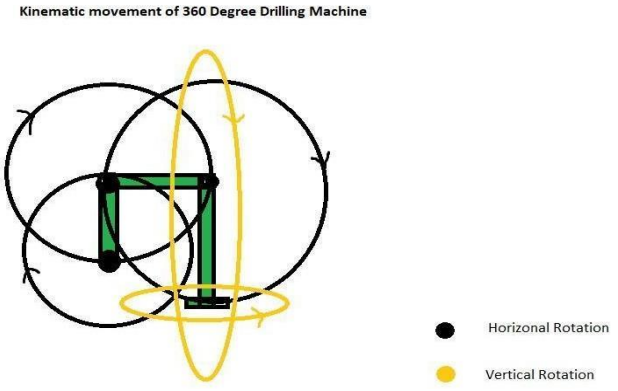


Fig 5. *Kinematic Movement of 360 Degree Drilling Machine*

## 6. ANALYSIS

The 360 Degree drilling machine analyzed using Fusion 360 Simulation Software. Various studies had to be done on the arms and the drill bits for the ultimate tensile strength and stress acted on the drilling machine. With the help of analysis, the design is iterated to get the higher efficiency of the drilling machine.The theoretical calculations concluded how the design of the connecting arms should be and the software analysis concluded the deformation of the setup during the drilling setup and operations.

### 6.1 STATIC STRESS

The most prevalent form of structural analysis utilizing the FE approach is static stress analysis. A component's or assembly's stress, strain, and deformation can be examined under a variety of load circumstances to ensure that costly failures are avoided during the design stage.Typical structural loads include one or more of the following:

- Clamping force in subsea connections is one example of external forces.
- Pressure loading in pressure vessels, for example, is an example of surface loads.
- Forces in the body (gravity, acceleration such as centrifugal force in rotating machines)

The multi-physics technique may also be used to simulate the structural response to more complicated loads, such as those resulting from thermal analysis. We did our simulation through Fusion 360.The Study is based on the four components :

- Connecting Arm 1(Mild Steel)
- Connecting Arm Linkage 2 (mild steel)
- Drill chuck (mild steel)
- Drill bit (High speed steel)

## 7. THEORETICAL ANALYSIS

### 7.1 Cutting Speed (V):

The rate at which the drill bit removes metal in one second. The drilling action in the workpiece is represented by the cutting speed. As a result, the mathematical calculations have been completed.

$$V = \pi DN$$

N=1650rpm V=284.86 mm/sec

### 7.2 Feed Rate (f):

Inches per minute, inch per bit revolution, number of bit revolutions per inch of advance, or feet per hour are the rates at which a drilling bit is advanced into or penetrates the rock formation being drilled. Forward speed is also known as cutting rate.

$$F = sfn$$

F = 40 mm/min.

**7.3 Depth of Cut (d):**

It is the entire amount of metal removed by the cutting tool in one pass. It is measured in millimeters. It varies depending on the tool and the work material. Mathematically, it is equal to half of the diameter difference.

d=D/2 d=1.5156

**7.4 Material Removal Rate :**

When conducting machining operations such as using a lathe or milling machine, the material removal rate (MRR) is the amount of material removed per time unit (typically per minute). The higher the material removal rate, the more material removed each minute.

MRR = (D*D/4)fN

MRR =493602.75 mm/min

**7.5 Machining Time:**

Simply multiply the length of the machining motion in inches by the feedrate in inches per minute.

t=L/f

Where,

L = length of the hole to be drilled

= 100mm

f = feed of the drill

= 42 mm/min

t =2.52 min

**7.6 Torque:**

Torque is the amount of force produced by the drill as it turns an object, not the speed at which it turns. Torque ratings have continuously increased in recent years, far above what is really required to fulfill applications.

P = 15 watts,

N=1750 rpm

P = 2πNT/60

T = P x 60/2*N

T = 15 x 60/2 x1750

T = 81.8531N-mm

## 8. RESULTS AND DISCUSSION

Our product's goal is to rotate 360 degrees and make it more user-friendly. Our 360-degree flexible drilling machine is smaller than previous models available on the market. As a result, getting from one place to another is relatively straightforward. This machine is lightweight and portable. The total amount of space needed is similarly little. We can drill holes in any direction at any moment with the help of this machine. This machine reduces manufacturing cycle time, eliminates re-clamping (once the workpiece is clamped in one direction, there is no need to re-clamp in a different direction), reduces the number of machines needed, and eliminates human error. The machine is quite easy to use. It is not as hefty as we had assumed, so anyone may operate it without difficulty. It surpasses our expectations and performs admirably.

The results obtained from the simulation satisfied the manufacturing criteria and withstand the high loads at the end of the connecting arms. This assures the different weight portable drilling machines can be clamped at the end of the connecting arms, It can withstand the load upto 57(566 N) kg of weight with the addition of gravity. The whole weight acts on the rotating point of the connecting arm and also satisfies the manufacturing requirements.

### 8.1 DRILL BIT

The main objective is to optimize to withstand the high load of the given load .In Fusion 360 simulation , this experimentation part is to be fixed with some constraints and the drill bit has to be given a force of 200 N from top load and the deformation result is 0.2 mm as shown in the Fig 8.1

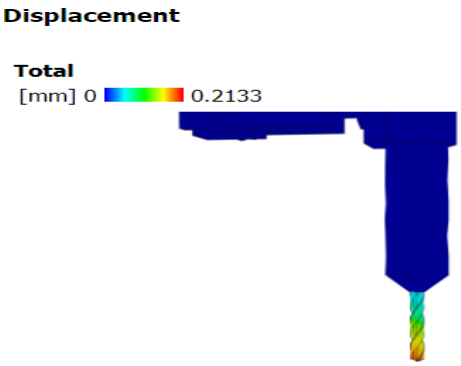


Fig 8.1 *Total deformation of drill bit*

### 8.2 DRILL CHUCK

The main objective in this drill chuck is to carry the drill bit with high loads of our given loads. So , in simulation the drill bit and upper part of the chuck is to be fixed with some constraints and the load acting on the surface of the chuck with the load of 250 N and the output results is getting some positive output and the deformation is 0.00325 mm as shown in the Fig 8.2 .

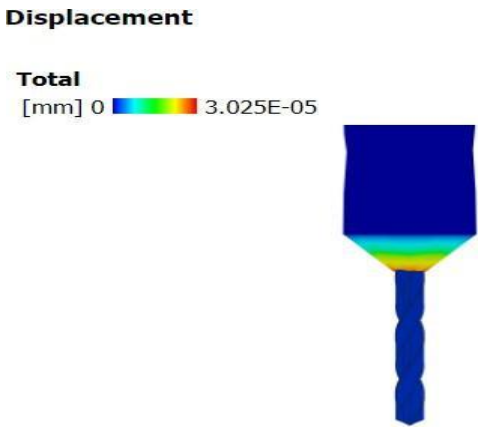


Fig 8.2 *Total deformation of drill chuck*

## 9. CONCLUSION

This project can be counted on to run well and at a low cost. This machine can execute a wide range of operations and holes. In comparison to other accessible resources, it is effective and cost-effective. While taking into account the model's applications and pricing, when compared to other machines, this machine becomes reasonably priced. This allows you to operate between the drill bit and the drill bed when room is at a premium. The advantage of this project are as follows :

- Drilling Efficiency
- Flexible
- 360 Degree Rotation
- Simple To Use
- Reduction Of Handling Cost
- Time Saving
- Reduction Of Overall Manufacturing Costs
- Improvement Of Productivity

Due to the various problems faced by conventional operation processes such as Poor thread finish, more time consumption, frequent tool breakage and many more. So, we have decided to design the machine which will make use of compressed air as a power source. Above is the Future model of drilling machine on which the drilling operation is achieved by 360 degree rotation system and it eliminates all the problem faced by conventional operation process. This 360 degree multi-operation Machine is to be presented for increasing their productivity as well as quality of job. It also gives a detailed description of machine mechanisms and their different main parts of the machine. In this we are defining different process parameters like spindle speed (rpm), cutting feed rate, cutting force, torque and power for their efficient working of operation. In this 360 degree drilling machine we designed and analysed our model to optimise how the connecting arm and joints can withstand and hold the drilling machine which will withstand high loads, ultimate tensile strength and yield stress with the help of fusion 360 simulation. In that result we calculate theoretical and analysed by the static stress structural method. In that we conclude the total deformation of the material, Reaction force of the part

Von-mises stress of the material which gives exact value of deformation. So we can achieve a high efficient drilling machine which is going to be an alternate drilling machine for future developments. There is no vibration in the connecting arms which provides accurate holes on the workpiece and do not cause deformation on their drill bits when the heavy load is applied. Hence the total drill setup improves the productivity of the manufacturing and time efficient. Once the setup is done, we can drill any type of drilling applications in any of axes and angles. This machine does not require skilled labourers as it is easy to learn and use which minimizes the handling stress of the operator. The addition of handle grip guides the labourer to make it more convenient. Our next study will be based on the real time applications of nothing but manufacturing. The analysis made on the manufacturing is compared with simulation phase to get the optimum results .The future study is based on the automatic 360 degree drilling machine with the replacement of connecting arms as telescopic arms. Joints are replacement of Ball joints. The motion of the arm movement is based on the sensors and the Programming logic controller.

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