DESIGN AND ANALYSIS OF HANDY DRILLING MACHINE FOR EDUCATIONAL PURPOSE (WOODWORK)

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DESIGN AND ANALYSIS OF HANDY DRILLING MACHINE FOR EDUCATIONAL PURPOSE (WOODWORK)

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ABSTRACT:
A drilling machine is a very basic instrument that is still used today. The conventional drill press machines are cumbersome, bulky, and difficult to carry anyplace. Other issues include the extremely small distance between the drill bit and the work. The use of a 360° flexible drilling machine can help overcome this issue. This machine is straightforward, portable, and capable of rotating in all four directions—vertically, horizontally, up, and down. This project's platform is a scissor lift jack that can raise and lower the machine. The instruments used to construct this machine include a welding machine, soldering gun, grinder, drill, rubber hammer, etc. This project design was created utilizing Autodesk Inventor software. The finished arm or links produce an angular motion that moves up and down. Next, this drilling device can drill through materials including ceramic tiles, metal, plastic, and wood. Because the drill power and torque are sufficient, this project is not intended for use in heavy industry. Only light industry use and small and medium-sized businesses are the focus of this project.

KEYWORDS: *Drilling Machine; Flexible; Linkages; Angular Movement*

1.0 INTRODUCTION

This drill machine could spin radially on the x and z axes and drill graphically in any direction. Consequently, using rotating hinges and connectors, a motor mount, and a supporting framework, we designed and constructed a 360° drilling machine for practical drilling operations. The drill chuck, an electric motor, and the system for driving the chuck at various speeds were all connected on the upper arm's pinnacle. The drill received power from the electric motor. Drilling device operating principle: A direct current motor coupled to a complete wave rectifier was the first step in the operation of the flexible drilling device, which potential energy source the rectifier received energy from. The armed then turned 360 degrees and performed activities all over the place, with drilling taking up most of the armed length. As a result, the operation's setup time was shortened, and the worked setting operation was not complicated. It was also thought to be the most effective way to operate the drilling machine manually (Farande et. al, 2019).

The 360° drill configuration was made up of various connecting arms that helped the drilling machine move in horizontal, vertical, and upside-down directions when mounted on a flat surface such as a table with swivel wheels. The project's goal was to create and test a 360° drilling machine that was more efficient than traditional drilling machines. The connecting armed was the most important aspect of the researched because it must be light in weight and bear strong stresses induced by the drill machine's weight, and the arms must be proportional for even weight distribution (Sumit, et. al, 2022). During drilling operations, the connecting armed shall not been distorted or fail in any way. This could cause the drill bit to slip, resulting in non-functional holes in the workpiece. Hollow bars were better for joining arms because they resisted vibrations and were lighter than solid bars. The drilling machine's kinematic movements were critical to the drill setup's proper operation. This research aided us in determining the right proportions for the connecting arms. This made it easier to maneuver the drill setup and ensured that the arms did not collide. (Sawarkar et. al, 2021). The connecting arms' movements were depicted in Figure 1.

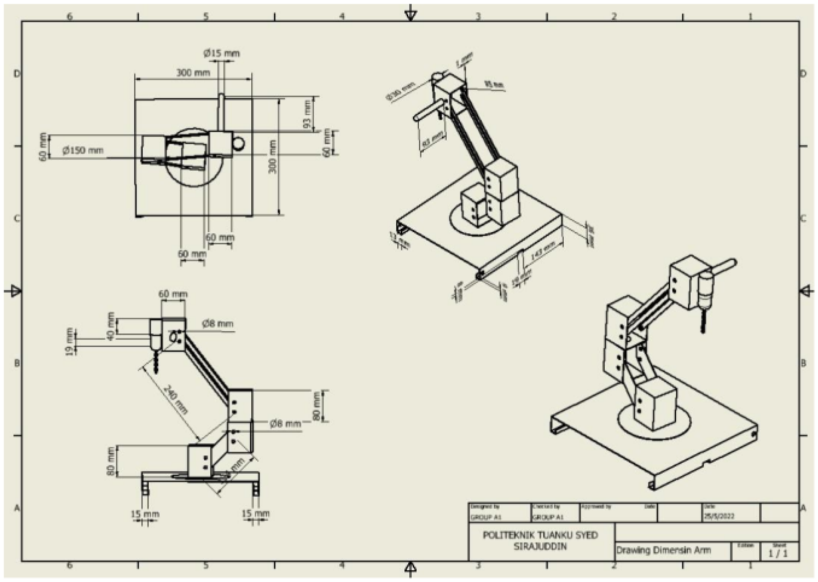

Figure 1: Project Dimensions

2.0 METHODOLOGY

The process flow chart as in Figure 2 shows the steps used to complete this project from the start until end.

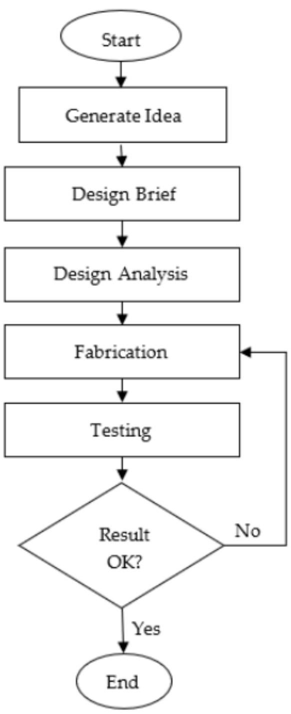

Figure 2: Design and Development Process

Several design parts were put forward to realize the idea. Subsequently, a design analysis was conducted to test the appropriate and safe design. In this part, Autodesk Inventor software was used and successfully decided the most suitable and safe design to use as shown in Figures 3 to 5 below.

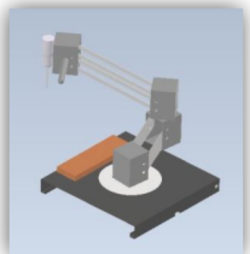

Figure 3: Arm Linkages

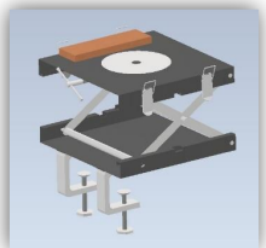

Figure 4: Scissor Jack

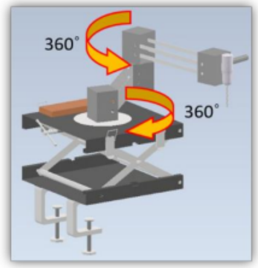

Figure 5: Arm Movements

Once the design was completed, the fabrication process was carried out as shown in Figures 6 to 8 below. The proposed 360° flexible drill may be mounted on a desk and additionally could been used to drill holes horizontally, vertically, or even the wrong way up. This drilling operation could also be carried out inside the lathe, wherein the drill was held within the tailstock and the paintings was held by using the chucked. The system might be capable of assisting the needy small-scale industries. This paper was about the design and fabrication of a 360º flexible drilling machine. This drill could get more flexibility to move in any route due to the linkages and its creation. 12 Volts and 20 Volts direct current motors were used to provide rotary motioned to the chucked and a battery and an on-on transfer manipulate contemporary and movement of the motor.

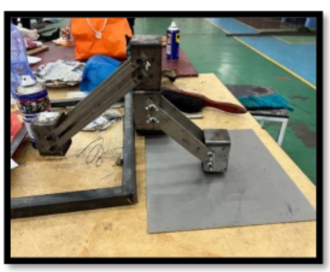

Figure 6: Base Plate Fabrication

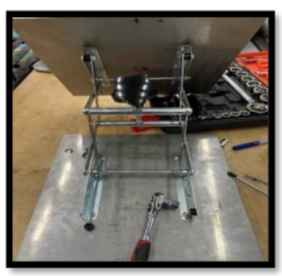

Figure 7: Scissor Jack Fabrication

Figure 8: Finalized Project

The design of 360º arm movement and drill were combined to drill on material become much easier. For the arm design, it is divided into two parts. The first part is the lower connecting arm that is locked in a 45º angle but can rotate 360º freely. The second part is the upper connecting arm which can move up and down freely and can also rotate 360º freely without any problem. This arm can reach a high object and can also be lowered to drill much shorter object. The drill is connected to a 20 Volts plug and are attached to the front end of the upper connecting arm. This drill can rotate at 1000 rpm and can penetrate through metal, plastic, and wood quite easily.

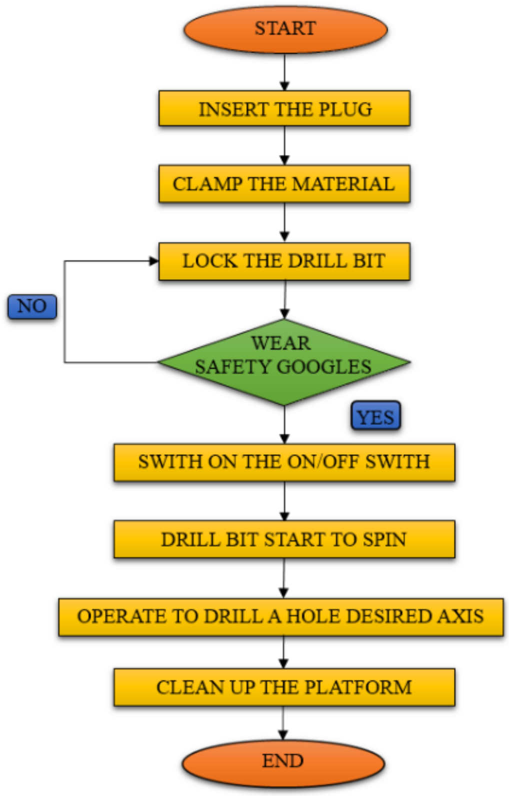

Figure 9: Operation flow chart of the Flexible Drilling Machine

The theory of this project was to use a 360° flexible drilling machine to drill a hole on the designed material. The 360° flexible drilling machine was attached to multiple arms or linkages that allowed the drill to move freely. In theory, the higher the power, the higher the torque produces. Power supply can be changed according to the machine. Some machines cannot stand a high-power supply or voltage in because it can cause the machine to break or function incorrectly. It is better to follow the specifications provided by the machine's supplier to ensure good and long-term usage of the machine.

2.1 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 = 10,000 rpm; D = 5 mm, hence V = 157079.63 mm/sec

2.2 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 = s f n

F = 40 mm/min

2.3 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 = 2.5

2.4 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) f N; MRR = 49,3602.75 mm/min

2.5 Machining Time

Simply multiply the length of the machine motion in inches by the feed-rate in inches per minute.

t = L / f

where,

L = length of the hole to be drilled

= 100 mm

f = feed of the drill

= 42 mm/min, hence, t = 2.52 min

2.6 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 fulfil applications.

P = 20 watts, N = 10,000 rpm

P = 2πNT/60

T = P x 60/2*N

T = 20 x 60/2 x10000

T = 6,000,000 N-mm

3.0 RESULTS AND DISCUSSIONS

For a variety of purposes, drilling is a method that is used to create a hollow or expand an existing hollow. to show off bendable hand drilling tools. Drilling is a cutting method that entails using a drill bit to make a circular pass-section hole in solid materials. The drill bit frequently functions as a multipoint rotary cutting tool. The bit is rotated at speeds ranging from hundreds to thousands of revolutions per minute while being pressed on the workpiece. The reducing zone is pressed against the workpiece when the hole is drilled, reducing chips (swarf) that would otherwise come out of the hole. Even though the bit is typically circled, the hole is frequently formed by pounding a drill bit into the hole with quick, repeated motions as opposed to a circular slicing action. With a pinnacle-hammer drill, the hammering operation can be carried out either inside or outside the hole (down-the-hole drill, DTH). Drills used for horizontal drilling are known as drifter drills. Making holes in a workpiece with metallic slicing tools is known as drilling. Drilling is a type of machining operation, along with trepanning, counter dulling, reaming, and boring. Most of these methods combine a linear feed with a primary rotation motion. Drilling for short hollows and deep holes has different properties. The size of the hole determines how much can be machined; the larger the hole, the more difficult it is to control the process and throw away the chips; small holes are common on many materials and high cloth.

Certain components cannot be drilled with standard drills because of the generally constrained space between the bit and the drill bed. We must use hand drills in these circumstances, however drilling with a hand drill has alignment issues. Therefore, we advise using a 360º flexible drill that can be mounted on a desk or wall and used to drill holes in all directions. As a result, it is safe to drill even intricate foundation pieces and surfaces. As a result, design and construct a 360º flexible drilling machine with rotating hinges and connectors, a motor mount, and a supporting shape for precise drilling operations. An essential piece of workshop equipment is a drilling system. Drilling can be accomplished quickly, cheaply, and easily in a drilling machine. By removing metallic material with the rotating edges of a drill, one can create a cylindrical hollow with a predefined diameter and intensity. The spindle of the drilling system contains the drill slicing tool. The target location is marked with an indentation using a center punch. Pressed into the work and fed into the indent is the rotating drill. You can drill the hole to the precise depth you want. Drilled holes can be distinguished by their burrs on the exit side and their sharp edges on the entrance side. On the interior of the hollow, there are typically feed markings as well. Drilling can also have an impact on the mechanical properties of the painting by leaving a very thin layer of highly confused and disturbed cloth on the freshly formed floor and lowering residual tension all around the opening. (Refer to Figure 10).

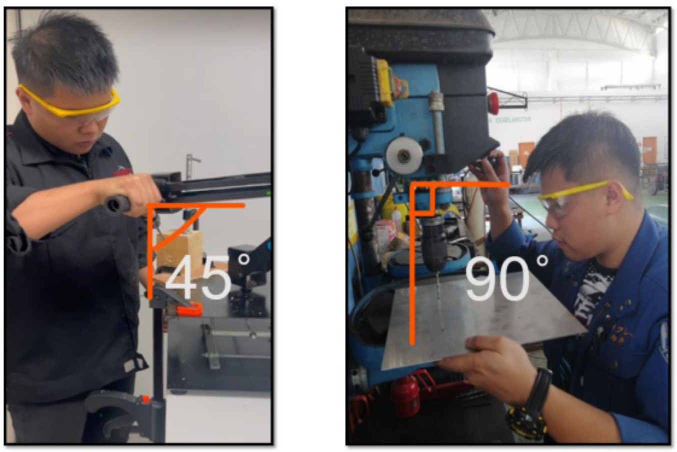

Figure 10: Different drill machine and angle

For drilling machine of 12 Volts;

(i) Wood – 1.4 cm (Thick), 45°

Size Drill Bit (mm)	Time (s)
1 mm	4.65
1.5 mm	4.10
2 mm	5.51
3 mm	24.86
4 mm	53.87

(ii) Wood – 1.4 cm (Thick), 30°

Size Drill Bit (mm)	Time (s)
1 mm	2.99
1.5 mm	2.96
2 mm	3.67
3 mm	18.60
4 mm	33.63

(iii) Plastic – 0.3 cm (Thick), 65°

Size Drill Bit (mm)	Time (s)
1 mm	2
1.5 mm	2.71
2 mm	2.83
3 mm	4.61
4.mm	9.51

(iv) Plastic – 0.3 cm (Thick), 35°

Size Drill Bit (mm)	Time (s)
1 mm	1.59
1.5 mm	1.56
2 mm	1.41
3 mm	1.66
4.mm	6.90

(v) Steel – 0.2 cm (Thick), 60°

Size Drill Bit (mm)	Time (s)
1 mm	11.52
1.5 mm	52.47
2 mm	34.00
3 mm	0
4.mm	0

(vi) Steel – 0.2 cm (Thick), 45°

Size Drill Bit (mm)	Time (s)
1 mm	8.15
1.5 mm	50.92
2 mm	25.48
3 mm	0
4.mm	0

For drilling machine of 20 Volts;

(i) Wood – 1.4cm (Thick), 65° (Arm angle)

Size Drill Bit (mm)	Time (s)
5 mm	4.94
6 mm	6.18
7 mm	6.24
8 mm	7.23
9 mm	7.45
10 mm	7.94

(ii) Wood – 1.4cm (Thick), 30° (Arm angle)

Size Drill Bit (mm)	Time (s)
5 mm	2.66
6 mm	4.32
7 mm	4.69
8 mm	6.33
9 mm	6.52
10 mm	6.91

(iii) Steel – 0.2cm (Thick), 65° (Arm angle)

Size Drill Bit (mm)	Time (s)
5 mm	9.33
6 mm	20.55
7 mm	32.66
8 mm	45.78
9 mm	52.32
10 mm	64.12

(iv) Steel – 0.2cm (Thick), 30° (Arm angle)

Size Drill Bit (mm)	Time (s)
5 mm	8.43
6 mm	18.77
7 mm	27.36
8 mm	35.56
9 mm	44.88
10 mm	52.22

(v) Plastic – 0.3cm (Thick), 65° (Arm angle)

Size Drill Bit (mm)	Time (s)
5 mm	3.70
6 mm	4.08
7 mm	4.25
8 mm	4.64
9 mm	5.01
10 mm	5.23

(vi) Plastic – 0.3cm (Thick), 30° (Arm angle)

Size Drill Bit (mm)	Time (s)
5 mm	2.00
6 mm	3.45
7 mm	3.69
8 mm	4.00
9 mm	4.37
10 mm	5.01

4.0 CONCLUSIONS

The time taken to drill into the workpiece at 65° arm angle is greater than on 30° arm angle. This is caused by the placement of handler hand at 65° arm angle that is higher than at 30° arm angle. The thrust given by handler could be different because of the height difference thus producing different result on time taken to drill into the workpiece (Refer to Figure 11).

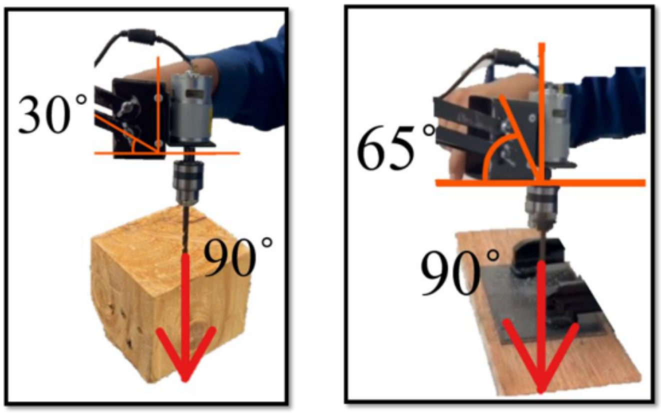

Figure 11: Different arm angle on machine

In testing, there are two drill machines used which are 12 Volts and 20 Volts. The 12 Volts drill machine is used to test drill bits from size 1 mm to 4 mm while the 20 Volts drill machine is used to test drill bits from size 5 mm to 10 mm. The angle and position of workpiece is the same but the result of 12 Volts drill machine on steel is almost the same as the 20 Volts drill machine even the size of the drill bit is different. This is caused by the different power input into the motor. The higher the power input, the higher the speed of the motor. This causes a difference in torque produced by the drill hence produces a different result.

In conclusion, the results prove this drilling machine can be used at different angles and with different sizes of drill bit, from 1 mm to 10 mm. The time taken depends on the thickness of materials such as wood, steel, and others. It also depends on the size of the drill bit used. Besides, individuals who want to use this machine should pay full attention and identify the angle to be used carefully so as not to suffer injury. Therefore, this machine was easy to use and carried everywhere.

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