Development and Prototyping of a Flexible Drill Press with Fabrication

Dr.ECCLESTON

[1] *Asst.Professor, Anil Neerukonda Institute of Technology & Sciences, Visakhapatnam- 531162, A.P., India*

[2] *Assoc. Professor, Anil Neerukonda Institute of Technology & Sciences, Visakhapatnam- 531162, A.P., India*

[3,4,5,6] *B.Tech, Anil Neerukonda Institute of Technology & Sciences, Visakhapatnam-531162, A.P., India*

Abstract

The primary objective of this project is to enhance the functionality of the existing drill press structure by introducing angular momentum to its vertical axis. This modification enables the adjustment of the drill press to desired inclinations, facilitating the drilling of holes at various angles. Additionally, it accommodates geometries that cannot be positioned precisely parallel to the drill base, thereby facilitating drilling in diverse configurations. Furthermore, the incorporation of rotary movement in the design enables the drilling of holes in heavy objects that are difficult to maneuver manually.

Keywords: Drill press,Inclined drilling, Angular Movement, Fabrication**.**

1. Introduction

Drilling, a fundamental machining technique, involves the creation of holes in a workpiece through the rotational action of a cutting tool known as a drill bit. The process entails applying force to the drill bit as it spins, effectively removing material and forming the desired hole. This can be accomplished manually with handheld drills or through mechanical means utilizing a drill press, also referred to as a drilling machine or pedestal drill [1]. A drill press is a fixed machining apparatus designed to achieve precise and consistent hole drilling in workpieces.

Characterized by components such as a base, column, table, spindle, and drill head, a drill press operates via a motor housed within the drill head, which drives a rotating spindle onto which the drill bit is affixed. Available in a range of sizes and configurations, from compact benchtop models to expansive industrial variants, drill presses offer distinct advantages over handheld counterparts [2]. These include heightened accuracy, stability, and the capacity to maintain uniform hole depths and angles.

In recent years, the significance of drill presses has grown considerably for efficient drilling operations. However, conventional drill presses may encounter limitations when faced with irregular geometries. Enhancing the structure of the drill press enables the drilling of holes in non-standard shaped specimens, while adjustments to the axis facilitate hole drilling with required inclinations. Moreover, for drilling holes in heavy objects without relocating the drill press, the ability to rotate the drill press platform proves invaluable [3].

2. Methodology

2.1 Methodology for Fabricating a Prototype Flexible Drill Press:

The construction of the prototype flexible drill press involves the fabrication of various components, each serving a specific function within the main assembly. The following outlines the fabrication process for each component:

- Base:

  Material: Mild steel

  Description: The base serves as the foundation for the drill press. It is constructed using mild steel and includes a vertical plate also made of mild steel. This plate provides stability and support for the entire assembly.

- Shaft:

  Material: Mild steel

  Description: The shaft is a crucial component that facilitates the vertical movement of the drill press. It is fabricated from mild steel and is attached to the vertical plate of the base using strategically placed holes, ensuring secure integration.

- Drill Press Mechanism:

  Materials: Stainless steel, springs, handle, fiber particles

  Description: The drill press mechanism is responsible for the drilling action. It is composed of stainless steel components, including springs for tension control, a handle for manual operation, and fiber particles for added durability and stability during operation.

- Bushes:

  Material: Cast iron

  Description: Bushes are essential for guiding and supporting the movement of the shaft. Fabricated from cast iron, they incorporate two slots to accommodate thread nuts, ensuring precise alignment and smooth operation of the drill press.

- Plot:

  Material: Mild steel

  Description: The plot serves as a structural component to hold the entire drill press mechanism in place. Fabricated from mild steel, it provides the necessary framework for assembly and ensures the stability of the overall device during operation.

  By following these fabrication guidelines, each component of the prototype flexible drill press can be constructed to meet the required specifications, ensuring optimal functionality and performance of the final assembly.

2. Fabrication

2.1 Fabrication process

The fabrication process involved the careful selection of materials followed by welding, fixing, fastening, and bending of sheet metals to assemble the flexible drill press. These fabrications were carried out utilizing the resources available in the mechanical department workshop. The final assembly of the prototype flexible drill press is depicted in Figure 1, with the fabrication process detailed as follows:

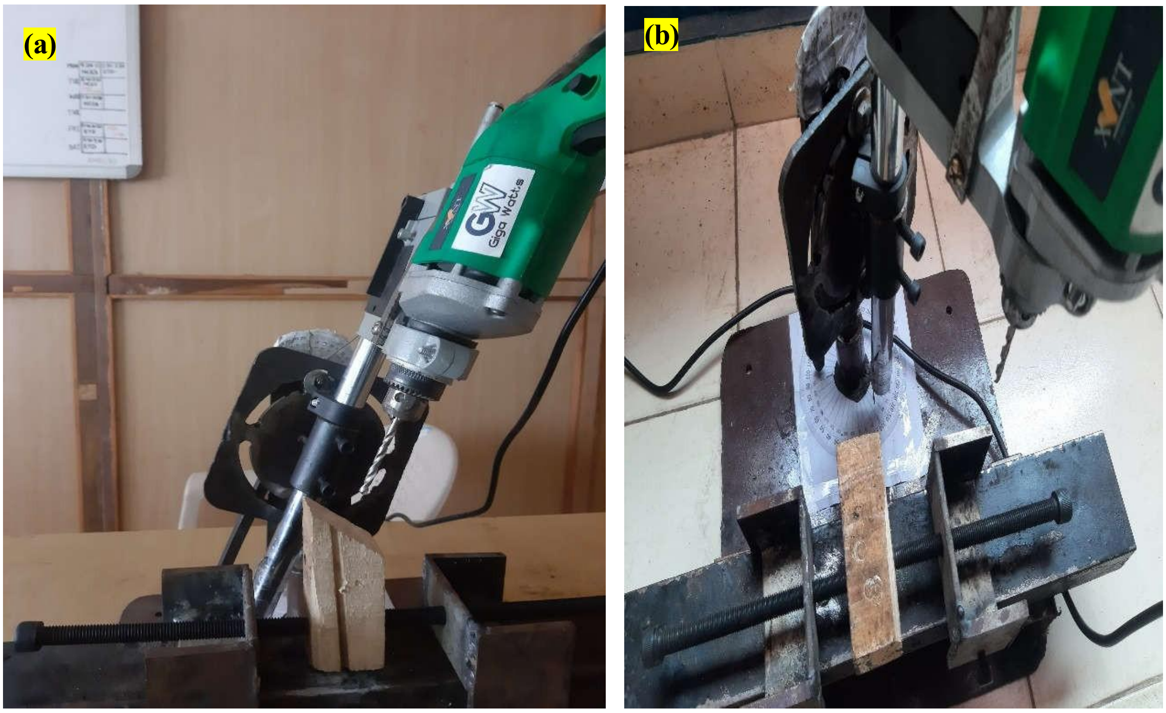

Fig.1: **Assembly of Prototype of flexible drill press (a) Drilling about Z-axis (b) Drilling about Y-axis**

- A metallic bush, 60mm in height, was welded at the center of the base plate. This bush featured two slots for thread nuts, facilitating the secure holding of the shaft.
- A metallic plate with unique holes of specified dimensions was welded onto the drill press. This plate serves the main purpose of rotation and angle holding.
- The drilling machine was securely fixed into the provided slot on the drill press.
- Wires from the drilling machine were attached to the multimeter.
- The overall welded drill press mechanism was then coupled to the shaft, allowing free rotation along the vertical axis and fixation at any inclination, resting on the vertical shaft. The specifications of the prototype flexible drill press are outlined in Table 1.

2.2 Material Selection and Design:

A variety of materials were carefully chosen for the fabrication of the prototype flexible drill press to withstand various stresses generated during hole drilling or physical loading. Utilizing strong materials enhances the overall load-bearing capacity, reducing vibrations and stiffness during operation.

2.3 Functionality:

The flexible drill press is designed for simplicity and versatility. It enables drilling at various angles by adjusting the column, allowing for angled and vertically oriented holes. Typically consisting of a lathe, column, and drill head assembly, this versatility proves useful for tasks requiring holes at non-standard angles, such as woodworking or construction. Additionally, it can rotate around its own axis, facilitating drilling for heavy objects that cannot be placed on the base of the drill press. This rotation capability also enables multiple drills in different workpieces without relocating the drill press, simply by maneuvering the work specimen around the drill press.

Table1: **Components and Specifications of Prototype flexible drill press**

Components	**Materials**	**Length (cm)**	**Thickness (cm)**	**Diameter (cm)**
Base	M.S	60	0.6	-
Shaft	Stainless steel	60	-	2.5
Plot	M.S	26	10	-
Bushes	C.I	6	-	2.5
Plate	M.S	15	0.6	-
Nuts and Bolts	M.S	5	-	0.6
Drilling machine	-		350w and rpm	

3. Results and discussion

Results and discussions have been provided regarding the performance of the drilling process, focusing on aspects such as hole alignment, drilling speed, and precision. Specific measurements and data related to these parameters have been outlined.

- Drill Machine Specifications:
  - Type: Alternating Current (A.C)
  - Rated Voltage: 35 volts
  - Working Voltage: 18 volts
  - Speed: 2600 revolutions per minute (R.P.M)
  - Maximum Power: 350 watts
- Chuck Specifications:
  - Diameter (Outside): 20 mm
  - Clamping Range: 2 mm – 10 mm
  - Taper: 6 mm
- Drill Bit Specifications:
  - Type: Twist Drill Bit
  - Diameter: 6 mm
  - Length: 70 mm
  - Material: High-Speed Steel (H.S.S)

3.1 Calculation Results:

- Cutting Speed (v):
  - Formula: $V = \pi * D * N$
  - Given N = 2600 rpm
  - Result: V = 81.26 mm/sec
- Feed Rate (f):
  - Formula: Feed rate = Rotational speed (N) * feed
  - Result: Feed rate = 55 mm/min
- Depth of Cut (d):
  - Formula: $d = D / 2$
  - Given D = 3 mm
  - Result: d = 1.5 mm
- Material Removal Rate (MRR):

Formula: MRR = (π * D^2 / 4) * f * N
Result: MRR = 8168140.89 mm^3/min

- Torque:
  Given Power (P) = 18 watts and N = 2600 rpm
  Formula: T = (P * 60) / (2 * π * N)
  Result: Torque (T) = 0.06 N-m

3.2 Discussion:

The provided measurements and calculations offer insights into the drilling process's performance. The cutting speed, feed rate, depth of cut, material removal rate, and torque have been quantified, indicating the efficiency and effectiveness of the drilling setup. These results enable an analysis of the setup's capability to achieve desired outcomes, such as hole alignment, precision, and drilling speed. Potential limitations or constraints observed during the drilling process could be considered, along with suggestions for future improvements or optimizations. Furthermore, the practical implications of these findings contribute to a broader understanding of drilling techniques and their applications, potentially informing future research and industrial practices.

4. Conclusions

The development and prototyping of a Flexible Drill Press with Fabrication demonstrate high efficiency and cost competitiveness. This multifunctional unit enables various operations and hole drilling within a single apparatus, maximizing efficiency and economy. Moreover, when evaluating its utility and project cost, it emerges as a cost-effective solution compared to alternative units.

5. Future Scope

- Future iterations of this research aim to advance drilling capabilities for hard materials.
- Automation presents an opportunity to replace manual adjustments of the drill press axis.
- Subsequent developments should focus on designing machines capable of drilling larger and more robust workpieces.
- Mild steel emerges as a viable alternative to stainless steel in fabricating the drill press.

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