

## **A REVIEW ON FACTORS TO BE CONSIDERED FOR EFFECTIVE DESIGN OF MAGNETIC CHUCK**

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### **ABSTRACT:**

The project "Design of Convertible and Affordable Magnetic Chuck" aims to develop an innovative magnetic chuck solution for work holding in precision grinding and turning of ferromagnetic materials. The design focuses on optimizing the work holding force, which is influenced by the texture and form of the work piece surface in contact with the chuck surface. The magnetic chuck is intended for use in factories for holding ferromagnetic work pieces during precision grinding and turning operations. The design emphasizes affordability, ensuring that the total cost of the magnetic chuck is within reach for manufacturers. Additionally, the magnetic chuck is designed to be lightweight and easy to transport, enhancing its usability and practicality in various industrial settings.

**Keywords:** **Keywords:** Magnetic Chuck, Work Holding, Precision Grinding, Ferromagnetic Materials, Work Holding Force.

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## 1. Introduction:

**1.1. Magnetic chuck failure prediction:** The paper presents a research paper that aims to develop a system to evaluate the applicability of magnetic clamping systems in milling operations. The system can predict the failure of the clamping system without experimentation and can be applied to different materials, processes or types of plate. [1]

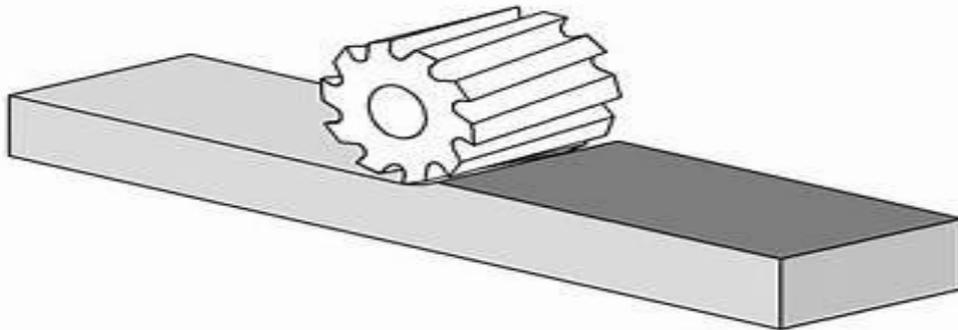
**Magnetic chuck model:** The paper describes a methodology to characterize the magnetic plates based on measuring the force applied on the work piece and the displacement of the work piece on the magnetic plate at the slippage instant. The system consists of data acquisition, signal conditioning and data processing components. [2]

**1.2. Milling forces model:** The paper also develops a mechanistic model of milling forces based on the specific cutting pressure and the coefficient of proportionality between the tangential and radial forces. The model uses experimental data and simulation software to obtain the constants for different materials and cutting conditions. [3]

**1.3. Methodology and results:** The paper explains the methodology for integrating the magnetic chuck model and the milling forces model to create a system of prediction. The system defines a safety factor and a failure criterion based on the mechanical stress and the limit of the magnetic plate. The paper validates the system with experiments on AISI D2 material and shows that the system can successfully characterize the instabilities caused by situations close to the limit of the magnetic plate.

## 2. The realm of milling operations:

In the realm of milling operations, a research paper has emerged as a beacon of innovation. It presents a system that can predict the failure of magnetic clamping systems, eliminating the need for experimentation. This system is versatile, capable of adapting to different materials, processes, and types of plate. The paper introduces a magnetic chuck model, a methodology that measures the force applied on the work piece and its displacement at the moment of slippage. Processing components. This model is a symphony of data acquisition, signal conditioning, and data



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Fig.2.1:-MILLING OPERATION [3]

But the innovation doesn't stop there. The paper also develops a mechanistic model of milling forces. This model, based on the specific cutting pressure and the coefficient of proportionality between the tangential and radial forces, uses experimental data and simulation software to obtain constants for different materials and cutting conditions.

The paper then weaves these two models together, integrating the magnetic chuck model and the milling forces model to create a predictive system. This system defines a safety factor and a failure criterion based on the mechanical stress and the limit of the magnetic plate. The paper validates the system with experiments on AISI D2 material, demonstrating that the system can successfully characterize instabilities caused by situations close to the limit of the magnetic plate.

Milling practice is a large and diverse area of manufacturing and toolmaking. It can produce very fine finishes and very accurate dimensions; yet in mass production contexts, it can also rough out large volumes of metal quite rapidly. It is usually better suited to the machining of very hard materials than is "regular" machining (that is, cutting larger chips with cutting tools such as tool bits or milling cutters), and until recent decades it was the only practical way to machine such materials as hardened steels. Compared to "regular" machining, it is usually better suited to taking very shallow cuts, such as reducing a shaft's diameter by half a thousandth of an inch or 12.7  $\mu\text{m}$ . So, in the world of milling operations, this research paper stands as a testament to the power of prediction and the potential of magnetic clamping systems .[3]

### **3. The realm of grinding operations:**

#### **3.1. Grinding Process:**

Grinding is a surface finishing operation where very thin layer of material is removed in the form of dust particles. Thickness of material removed is in range of 0.25 to 0.50 mm. Tool used is a abrasive wheel Grinding machine is a power operated machine tool where, the work piece is fed against constantly rotating abrasive wheel to remove thin layer of material from work.

[4]

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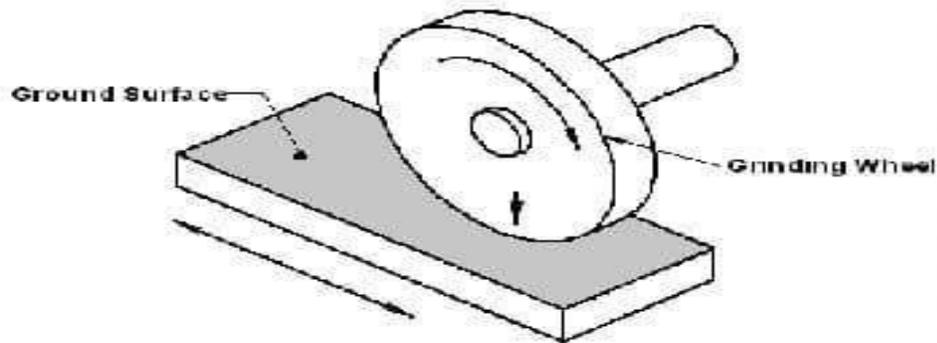


Fig.3.1:-GRINDING OPERATION [4]

**3.2. Grinding subset:** Grinding is a subset of cutting, as grinding is a true metal-cutting process. Each grain of abrasive functions as a microscopic single-point cutting edge (although of high negative rake angle), and shears a tiny chip that is analogous to what would conventionally be called a "cut" chip (turning, milling, drilling, tapping, etc.) [citation needed]. However, among people who work in the machining fields, the term cutting is often understood to refer to the macroscopic cutting operations, and grinding is often mentally categorized as a "separate" process. This is why the terms are usually used separately in shop-floor practice.

On its surface, grinding seems simple: a machine takes a rotating tool (usually a wheel) with abrasive grains and applies it to a workpiece's surface to remove material. Each grain is its own miniature cutting tool, and as grains dull, they tear from the tool and make new, sharp grains prominent.

But there are many variations, approaches and considerations for this type of machining, each of which is particularly effective for certain applications with certain materials. [4]

### 5. Magnetic chucks:

**5.1. Magnetic chucks using:** are commonly used for factoring of ferromagnetic work pieces in precision grinding and turning operations. They typically use an electromagnet or a permanent magnet to hold the work piece during machining. illustrates the working principle of a magnetic chuck. When placed on the chuck surface, the work piece provides a flow path for the magnetic flux thus completing the magnetic circuit. The force of attraction produced by this circuit holds the work piece against the chuck surface. Magnetic chucks offer several advantages over conventional work holding methods such as three-jaw chucks. Unlike the three-jaw chuck, magnetic chucks produce very little elastic deformation of the work piece and thus enable tight dimensional and form tolerances to be held. Additionally, the work piece setup and changeover times are much lower for magnetic chucks (Barton, 1997). However, a key problem with magnetic chucks is that the force

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required to hold the work piece without any slip is often not known. Although users of magnetic chucks know that factors such as material hardness, surface contact conditions, and chuck design. [5]

### **5.2. Work piece Flatness:**

Work piece flatness is crucial for achieving uniform and strong magnetic holding force. A flat work piece ensures that a maximum number of magnetic poles within the chuck make direct contact with the work piece surface, leading to a more secure grip. If the work piece is not sufficiently flat, there can be uneven contact between the chuck and the work piece. This results in magnetic flux leakage and reduced holding force. In extreme cases, if the work piece has high areas or warping, it may not make good contact with the chuck, leading to a loss of magnetic force and potential work piece instability during machining [6].

To maximize holding force, it's essential to maintain tight tolerances on work piece flatness.

### **5.3 Surface Finish:**

The surface finish of the work piece can affect the holding force in several ways. A smooth and clean surface typically results in better magnetic adhesion. Rough or uneven work piece surfaces can create air gaps between the work piece and the magnetic chuck, reducing the magnetic attraction and the overall holding force. [7]

Contaminants, such as dirt, oil, or rust, on the work piece surface can also interfere with the magnetic grip. Clean, well-prepared work piece surfaces are essential for optimal holding force. [8]

An experimental approach to electromagnetic chucking forces involves conducting tests and measurements to understand and quantify the magnetic forces generated by an electromagnetic chuck. Electromagnetic chucks use electric currents to create a magnetic field, which holds ferrous work pieces in place during machining. The following steps outline how to approach experimental investigations of electromagnetic chucking forces. [8]

#### **5.3.1. Equipment Setup:**

Prepare the necessary equipment, including the electromagnetic chuck, a power supply, a force measurement device (such as a dynamometer or load cell), and any instrumentation for data collection and analysis. [9]

#### **5.3.2. Work piece Preparation:**

Select a suitable ferrous work piece for the experiment. Ensure that the work piece is clean and free from contaminants that could affect the magnetic grip. [10]

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Work piece is fed against the rotating abrasive wheel. Due to action of rubbing or friction between the abrasive particles and work piece materials removed. [10]

### **5.3.3. Electromagnetic Chuck Configuration:**

Set up the electromagnetic chuck according to the manufacturer's specifications, including the proper voltage and current settings. Ensure that the chuck is securely mounted to the machine tool. [11]

### **5.3.4. Force Measurement:**

Position the force measurement device between the electromagnetic chuck and the work piece. This device will measure the attractive force generated by the chuck.[12]

### **5.3.5. Voltage and Current Control:**

Gradually apply the voltage and current to the electromagnetic chuck, gradually increasing the magnetic field strength. Measure the force exerted on the work piece at various voltage and current levels. [13]

### **5.3.6. Data Collection:**

Record the force measurements as a function of voltage, current, and any other relevant parameters. This data will help create a force profile for the electromagnetic chuck.[14]

### **5.3.7. Impact of Air Gap:**

Vary the air gap distance between the chuck and work piece to see how it affects the magnetic holding force. Record the data to understand the relationship between the air gap and the chucking force. [15]

## **6. Documentation:**

Document the experimental procedure, findings, and any important conclusions. This documentation will be valuable for future reference and for sharing results with colleagues or within your organization [16]

An experimental approach to electromagnetic chucking forces helps in understanding the behaviour of these devices under different conditions, allowing for more precise control and optimization of magnetic holding forces during machining processes. Attraction force of the magnetic chuck obtained by using linear and nonlinear calculations are compared with the measured ones. It has been shown that assuming proper B-H curves are necessary to obtain accurate attraction force before calculations. [17]

It is also noted that the numerical calculations can be a powerful tool to understand the performance of the chucks on the market and to develop new-structured ones.[18]

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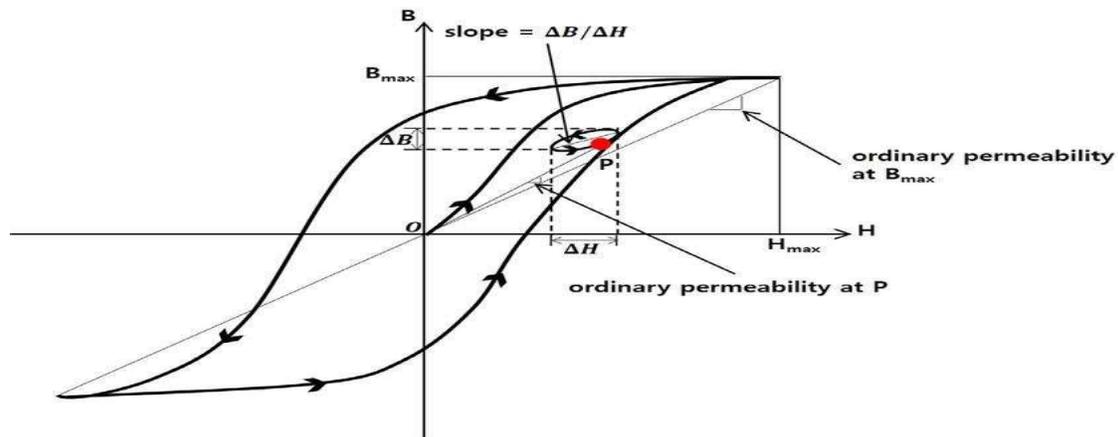


Fig.6.1:-B-H CURVES [18]

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