DESIGN AND FABRICATION OF CHIP REMOVAL FOR GEAR HOBBING MACHINE

A PROJECT REPORT

Submitted by

KAVIYARASAN C 8115U23ME023

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Under the Guidance of

Dr. D. JAFERY DANIEL JAMES, M.E., Ph.D.,

Department of Mechanical Engineering

K. RAMAKRISHNAN COLLEGE OF ENGINEERING

MECHANICAL ENGINEERING

K. RAMAKRISHNAN COLLEGE OF ENGINEERING

(AUTONOMOUS)

Under

ANNA UNIVERSITY, CHENNAI

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(AUTONOMOUS)
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BONAFIDE CERTIFICATE

Certified that this project report titled "**DESIGN AND FABRICATION OF CHIP REMOVAL FOR GEAR HOBBING MACHINE "is** the bonafide work of **KAVIYARASAN C (8115U23ME023)**who carried out the work under my supervision.

Dr. H. RAMAKRISHNAN, Ph.D.,
HEAD OF THE DEPARTMENT
ASSISTANT PROFESSOR,
Department of Mechanical Engineering
K. Ramakrishnan College of
Engineering, (Autonomous)
Samayapuram, Trichy.

Dr. D. JAFERY DANIEL JAMES, M.E., Ph.D.,
SUPERVISOR
ASSISTANT PROFESSOR,
Department of Mechanical Engineering,
K. Ramakrishnan College of
Engineering, (Autonomous)
Samayapuram, Trichy.

SIGNATURE OF INTERNAL EXAMINER

NAME:

DATE:

SIGNATURE OF EXTERNAL EXAMINER

NAME:

DATE:

K. RAMAKRISHNAN COLLEGE OF ENGINEERING

(AUTONOMOUS)

Under

ANNA UNIVERSITY, CHENNAI

DECLARATION BY THE CANDIDATE

I declare that to the best of my knowledge the work reported here in has been composed solely by myself and that it has not been in whole or in part in any previous application for a degree.

Submitted for the project Viva- Voce held at K. Ramakrishnan College of Engineering on _________

SIGNATURE OF THE CANDIDATE

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ABSTRACT

The effective removal of chips during the gear hobbing process is crucial to ensuring precision, operational efficiency, and machine longevity. This project focuses on the design and fabrication of a chip removal system tailored specifically for gear hobbing machines. The primary objective is to enhance the productivity of the machining process by preventing chip accumulation, which can lead to tool wear, surface defects, and reduced operational efficiency. The proposed system integrates mechanical and pneumatic components to efficiently collect and dispose of chips generated during the hobbing operation. The design includes a strategically positioned collection mechanism, an optimized suction or conveyance system for chip evacuation, and a storage unit for temporary chip holding. Computational analysis and experimental validation ensure the system's effectiveness in diverse operating conditions.

Key Words: *Chips, Gear Hobbing, Design and Fabrication, Chip Removal System, Operational Efficiency, Tool Wear, Pneumatic Components*

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CHAPTER 1
INTRODUCTION

In a bustling manufacturing facility, rows of machines hum in unison, cutting, shaping, and refining metal into precise components. Among them, the gear hobbing machine plays a pivotal role in crafting gears, the very heart of mechanical systems. However, operators frequently face a persistent challenge: managing the buildup of chips generated during machining. These small yet problematic remnants of material can lead to clogged machines, increased tool wear, and compromised product quality, causing delays and escalating production costs. Inspired by this recurring issue, this project seeks to address the problem with an innovative Chip Removal System, designed to transform this obstacle into an opportunity for efficiency and economic growth. The system leverages real-time data analysis to monitor critical parameters such as chip volume, cutting speed, and tool load. By integrating advanced sensors and adaptive mechanisms, it continuously evaluates machining conditions and adjusts the removal process dynamically. For instance, during a trial at a local facility, a real-time feedback system detected a surge in chip accumulation and instantly activated enhanced suction, preventing downtime and safeguarding the tool. Such proactive measures not only minimize disruptions but also reduce operational costs by lowering tool wear, maintenance expenses, and energy consumption. These cost savings directly impact the bottom line, making manufacturing processes more profitable and sustainable.

Moreover, by increasing machine uptime and ensuring the consistent production of high-quality components, this chip removal system supports manufacturers in scaling operations to meet higher demands. The economic benefits extend beyond the factory floor, enabling businesses to remain competitive in global markets and contributing to local economies through job creation and resource optimization. This project not only addresses an industry pain point but also represents a step forward in building smarter, data-driven manufacturing systems that drive profitability and innovation. The proposed chip removal system incorporates several advanced components to ensure effective performance. Sensors play a critical role in real-time monitoring of machining parameters. Load sensors measure the stress on tools during operation, allowing for early detection of anomalies that could affect performance. Optical sensors are used to monitor chip accumulation, ensuring no material buildup hinders the process. Additionally, vibration sensors detect irregularities caused by blockages or excessive chip loads, enabling timely corrective actions.

For chip transportation, the system utilizes mechanisms such as vacuum suction, conveyor belts, and coolant wash systems. Vacuum suction systems remove chips directly from the cutting zone, preventing them from interfering with the machining process. Conveyor belts efficiently transport the removed chips to collection points for disposal or recycling. Coolant wash systems, on the other hand, flush out chips from hard-to-reach areas, ensuring a clean working environment around the cutting tools.

Automation further enhances the system's efficiency through IoT-enabled connectivity and smart integration. The chip removal system can be connected to the factory's monitoring network, providing operators with real-time feedback and predictive maintenance alerts. A closed feedback loop adjusts the removal process dynamically, ensuring optimal performance even under varying machining conditions .An efficient chip removal system offers significant economic benefits, both directly and indirectly. By prolonging tool life, the system reduces costs associated with frequent tool replacements. Efficient chip management also minimizes power losses caused by blockages and overloads, resulting in lower energy consumption. Furthermore, the reduced downtime and maintenance requirements save manufacturers both time and money, allowing for a more streamlined production process.

CHAPTER 2

LITERATURE REVIEW

Chip management has been a critical aspect of manufacturing processes, particularly in high-precision machining operations such as gear hobbing. The formation and removal of chips significantly influence tool life, surface finish, and overall process efficiency. In "Manufacturing Technology: Metal Cutting and Machine Tools" by P.N. Rao, the author highlights the adverse effects of chip accumulation on machining performance. Rao explains that excessive chip buildup can cause overheating, tool wear, and dimensional inaccuracies in the finished product. The text further explores the importance of implementing effective chip removal strategies to maintain continuous operation and achieve better machining quality. Traditional methods such as manual chip clearance or basic mechanical transport are often inefficient and prone to human error, underlining the need for automated systems that can adapt dynamically to varying cutting conditions.

Automation and real-time monitoring in chip removal systems have been explored in depth in "Fundamentals of Modern Manufacturing" by Mikell P. Groover. Groover emphasizes the integration of sensors and feedback mechanisms to monitor parameters like chip load, cutting force, and temperature. He highlights that modern manufacturing demands systems that not only remove chips but also optimize the removal process based on real-time data. By employing techniques such as vacuum-assisted suction, coolant-based flushing, and conveyor-based chip transportation, manufacturers can significantly reduce downtime and improve tool longevity. Groover also notes the role of predictive maintenance, where sensor data is used to identify potential issues before they lead to process interruptions. These advancements are especially relevant in gear hobbing, where precision is paramount, and even minor disruptions can have a cascading effect on the quality of the output.

Further insights can be drawn from "Principles of Metal Cutting" by G.K. Lal, where the focus is on the thermomechanical aspects of chip formation and removal. Lal explores how chip morphology, influenced by cutting speed, tool material, and workpiece properties, affects the efficiency of removal systems. The text suggests that understanding the behavior of chips at a microscopic level can aid in designing systems that handle chips more effectively. For instance, spiral or continuous chips, often encountered in gear hobbing, require specific removal techniques to prevent entanglement with the cutting tool or workpiece. This insight reinforces the necessity of tailoring chip removal systems to the unique requirements of gear hobbing machines.

Collectively, these studies highlight the importance of integrating advanced technologies in chip management systems to enhance the productivity and sustainability of machining operations. By leveraging real-time data analysis, automated controls, and optimized designs, manufacturers can address longstanding challenges in chip removal, thereby achieving greater efficiency, reducing operational costs, and ensuring the consistent production of high-quality components.

In addition to the advancements in automation and real-time monitoring, the economic and environmental benefits of efficient chip removal systems have been well-documented in literature. “Advanced Machining Processes” by W. Brian and R. Ward discusses how effective chip management contributes not only to enhanced productivity but also to reduced energy consumption and minimized material waste. The authors emphasize that poor chip removal can lead to energy losses, as machines struggle to maintain cutting efficiency under suboptimal conditions, often requiring more power to overcome tool resistance caused by chip buildup. A study conducted in a gear manufacturing facility revealed that the introduction of an automated chip removal system led to a 20% reduction in energy usage, directly improving the profitability of operations. Furthermore, byimproving the quality of machining, such systems reduce the incidence of defective parts, which lowers scrap rates and material costs. Another key factor highlighted by “Introduction to Manufacturing Processes” by Mikell P. Groover is the role of sustainable manufacturing practices in modern production systems. Groover argues that efficient chip removal systems contribute to sustainability goals by facilitating the recycling of chips, reducing the environmental impact of waste disposal, and conserving raw materials. The development of systems capable of handling various chip forms—whether fine particles or large, continuous strands—requires a deep understanding of material behavior, as discussed in "Machining and Machine Tools" by A.B. Gupta. Gupta explains that each chip type requires tailored removal methods, which can be optimized using real-time data to reduce the overall waste and improve the quality of the final product. Thisis especially critical in high-precision manufacturing like gear hobbing, where chips must be continuously cleared without disrupting the cutting process. The integration of such advanced systems not only boosts operational efficiency but also drives long-term economic growth by reducing maintenance costs, increasing machine uptime, and supporting eco-friendly practices in the manufacturing sector.

CHAPTER 3

PROBLEM IDENTIFICATION

Chip Accumulation:

In gear hobbing, chips can accumulate rapidly around the cutting area, leading to blockages that interfere with the machining process. If not promptly removed, they can damage the cutting tool or the workpiece.

Tool Wear and Tear:

Inefficient chip removal results in excessive friction between chips and the cutting tool. This accelerates tool wear, requiring more frequent replacements and leading to increased operational costs.

Reduced Cutting Efficiency:

Chip buildup can restrict the cutting action, reducing the efficiency of the gear hobbing process. The machine may require additional power to overcome the resistance caused by accumulated chips, which impacts productivity.

Inconsistent Surface Finish:

Improper chip removal can affect the quality of the machined surface. Chips that get reintroduced into the cutting zone can cause scratches or uneven finishes, resulting in non-conforming parts.

Overheating of Cutting Tools:

Chips that are not removed effectively trap heat around the cutting tool, leading to overheating. This reduces tool life and can result in thermal damage to both the tool and the workpiece

Increased Machine Downtime:

When chip removal is inefficient, machines experience more frequent breakdowns, leading to unplanned downtime. This significantly hampers production schedules and increases maintenance costs.

Labor Intensive Operations:

Traditional manual methods of chip removal are labor-intensive and time-consuming. These methods require frequent operator intervention, which reduces the overall efficiency of the machining process.

Environmental Concerns:

Accumulation of chips in the machining area can lead to poor working conditions, including cluttered environments that make the workspace hazardous for operators. Moreover, inefficient chip management contributes to material waste and disposal challenges.

Difficulty in Handling Various Chip Types:

Different machining conditions produce different types of chips, such as fine particles, curls, or continuous strands. Each type requires a specialized removal technique, which can be difficult to handle without an automated system that adapts to these variations.

Inconsistent Production Quality:

Without a reliable chip removal system, inconsistent machining conditions can lead to variations in gear quality, such as dimensional inaccuracies or surface imperfections. This affects product consistency and can result in the need for rework or scrap.

CHAPTER 4
OBJECTIVES

Design an Automated Chip Removal System:

To design and develop an efficient, automated chip removal system tailored for gear hobbing machines, utilizing real-time data analysis to ensure consistent and effective chip removal.

Enhance Operational Efficiency:

To improve machining productivity by minimizing downtime, preventing chip accumulation, and ensuring uninterrupted operation through real-time monitoring and dynamic adjustments to chip removal processes.

Increase Tool Life and Reduce Maintenance Costs:

To extend the life of cutting tools by reducing friction and overheating caused by chip buildup, thereby lowering maintenance costs and improving overall machine longevity.

Improve Product Quality:

To ensure high-quality gear production by preventing chip interference that could lead to surface defects, dimensional inaccuracies, or part rejection, maintaining consistent machining standards.

Optimize Resource Utilization and Sustainability:

To reduce energy consumption, minimize material waste, and promote sustainable manufacturing by integrating eco-friendly chip removal practices that allow for chip recycling and reduce environmental impact.

CHAPTER 5
SELECTION OF MATERILS

DC MOTOR

DC MOTOR PRINCIPLE:

A DC (Direct Current) motor operates on the principle of electromagnetic induction, which states that when a current-carrying conductor is placed in a magnetic field, it experiences a force. This force generates torque that causes the motor's rotor (the rotating part) to turn..

WORKING OF AC MOTOR:

Current Flow:

When DC voltage is applied to the motor, current flows through the armature windings.

Magnetic Field Interaction:

The current in the armature windings interacts with the magnetic field of the stator, creating a force (Lorentz force) according to F = BIL (Force = Magnetic Field Strength * Current * Length of Conductor).

Torque Generation:

This force generates torque on the rotor, causing it to rotate.

Commutator Action:

As the rotor turns, the commutator reverses the current in the armature windings to maintain continuous rotation in the same direction.

Continuous Rotation:

The rotor keeps rotating, converting electrical energy into mechanical energy.

The direction of rotation depends on the direction of the current and the polarity of the magnetic field. By varying the voltage or current, the motor's speed and torque can be controlled.

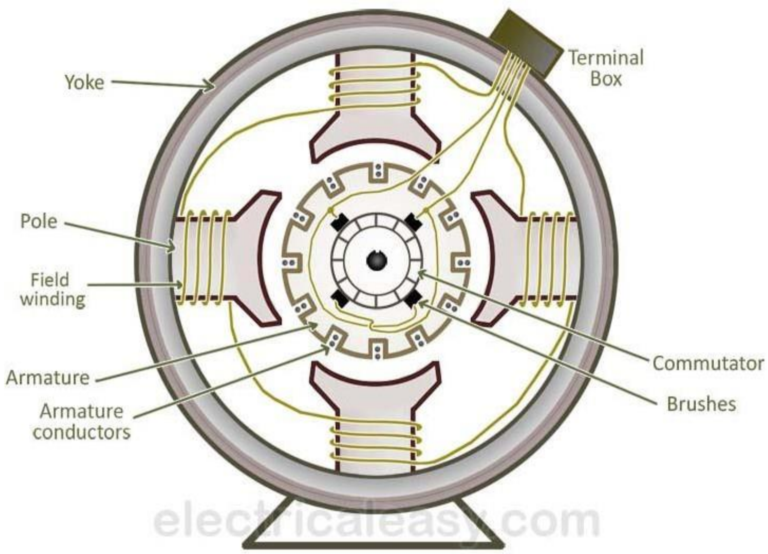


Fig 1.1 DC Motor

DC MOTOR MECHANISM:

The mechanism of a DC motor is based on the fundamental principle of electromagnetic induction, where a current-carrying conductor experiences a force when placed in a magnetic field. In a DC motor, this principle is applied to the interaction between the magnetic field produced by the stator (the stationary part) and the current flowing through the armature (the rotating part). The armature consists of coils of wire, and when a direct current flows through these coils, it generates its own magnetic field. This magnetic field interacts with the magnetic field from the stator, resulting in a force that acts on the armature. According to Lorentz's Force Law, this force is perpendicular to both the direction of the magnetic field and the current, generating a torque on the rotor and causing it to rotate.

The rotation of the armature continues as the current in the windings interacts with the stator's magnetic field, converting electrical energy into mechanical energy. To ensure that the armature continues to rotate in one direction, the current flowing through the armature needs to reverse at appropriate intervals. This reversal is achieved by the commutator, a mechanical switch that periodically changes the direction of current in the armature windings. Without this action, the rotor would stop after half a rotation, as the magnetic fields would oppose each other. The commutator is connected to the armature shaft and works in tandem with brushes—carbon or graphite components that maintain electrical contact between the stationary power supply and the rotating commutator.

CAST IRON FRAME:

A cast iron frame is a structural component commonly used in various industrial machinery, including electric motors, pumps, engines, and other mechanical systems. It serves as the outer shell or housing that supports and protects the internal components of the machine. The use of cast iron for the frame is preferred due to its unique properties that make it suitable for demanding mechanical applications.

Properties of Cast Iron:

Cast iron is an alloy primarily composed of iron, carbon, and silicon, with the carbon content typically ranging from 2% to 4%. It has several advantageous properties, such as:

High Strength and Durability:

Cast iron is strong, making it ideal for frames that must support heavy loads and resist mechanical stress.

Good Castability:

It can be easily molded into complex shapes, allowing for the creation of intricate frame designs.

Vibration Damping:

Cast iron has excellent vibration-damping properties, which is particularly important in motors and machinery. This helps reduce noise and wear during operation.

Corrosion Resistance:

Although not as resistant to corrosion as some other materials, cast iron still offers a good level of resistance, especially when compared to other metals like steel.

Heat Resistance: Cast iron can withstand high temperatures, making it suitable for environments where heat dissipation is crucial, such as in electric motors.

APPLICATION ON MACHINARY:

The cast iron frame is used in various machinery to provide strength and stability. In electric motors, for example, the frame houses components such as the stator and rotor, ensuring that these parts remain in place and protected from external damage. The heavy, solid nature of cast iron also helps to absorb any operational vibrations, enhancing the longevity and smooth functioning of the motor. In pumpsand engines, the frame protects sensitive internal components from external forces while also contributing to the overall stability and performance of the system.

ADVANTAGES OF CAST IRON FRAMES:

- **Cost-Effective**: Cast iron is relatively inexpensive compared to materials like steel or aluminum, making it a cost-effective choice for manufacturing frames.

- **Ease of Manufacturing:** It can be easily cast into complex shapes, allowing for efficient production of frames with intricate geometries.

- **Long Lifespan:** Cast iron components are known for their durability, making them ideal for long-term, heavy-duty applications.

- **Low Maintenance:** Cast iron frames generally require minimal maintenance, especially when properly treated to prevent corrosion.

CAST IRON :

Cast iron is a group of iron-carbon alloys that contain over 2% carbon. It is widely recognized for its excellent castability, high compressive strength, and resistance to wear and deformation. Its versatility makes it an essential material in various industrial applications, from construction to automotive manufacturing. Cast iron is typically composed of 2–4% carbon, 1–3% silicon, and the remainder iron, with small amounts of manganese, sulfur, and phosphorus as impurities.

TYPES OF CAST IRON :

There are several types of cast iron, each with distinct properties. Gray cast iron, named for its gray fractured surface due to graphite flakes, is the most commonly used type. It is brittle but has excellent machinability and compressive strength, making it suitable for engine blocks and piping. White cast iron lacks graphite but contains carbides, giving it exceptional hardness and abrasion resistance; it is often used in industrial wear applications like crushers and mill liners.

Ductile cast iron, also known as nodular cast iron, contains spherical graphite nodules instead of flakes, enhancing its ductility and tensile strength. This type is used in automotive parts, gears, and pipes where toughness is critical. Malleable cast iron is produced by heat-treating white cast iron to make it more ductile and machinable, ideal for small, detailed castings like brackets and hardware. Lastly, alloyed cast iron incorporates elements like chromium, nickel, and molybdenum to enhance properties such as corrosion resistance and heat tolerance, often used in demanding environments like chemical plants and high-temperature applications.

APPLICATIONS AND ITS ADVANTAGES :

The versatility of cast iron lies in its ability to combine strength, durability, and cost-effectiveness. Its resistance to wear makes it indispensable in heavy-duty applications, while its castability allows the production of complex shapes with minimal machining. However, it is important to note that cast iron is generally brittle and lacks the tensile strength of steel, limiting its use in applications requiring high flexibility. Despite this, its unique properties and wide range oftypes ensure cast iron remains a cornerstone of modern engineering and manufacturing.

5.5 WOODEN PLATE:

Wooden plates, commonly used in various applications, offer distinct advantages due to the properties of wood. These plates are utilized in construction, manufacturing, and even daily life because of their durability, versatility, and environmental benefits.

Shock Absorption:

Wooden plates effectively absorb shocks and vibrations, making them ideal for supporting loads or as temporary structures in construction. Their resilience prevents damage to delicate materials and machinery.

Lightweight and Easy to Handle:

Wood is lighter than metals or composites, which makes wooden plates easy to transport and install. This property is particularly advantageous in applications requiring mobility or manual handling.

Cost-Effectiveness:

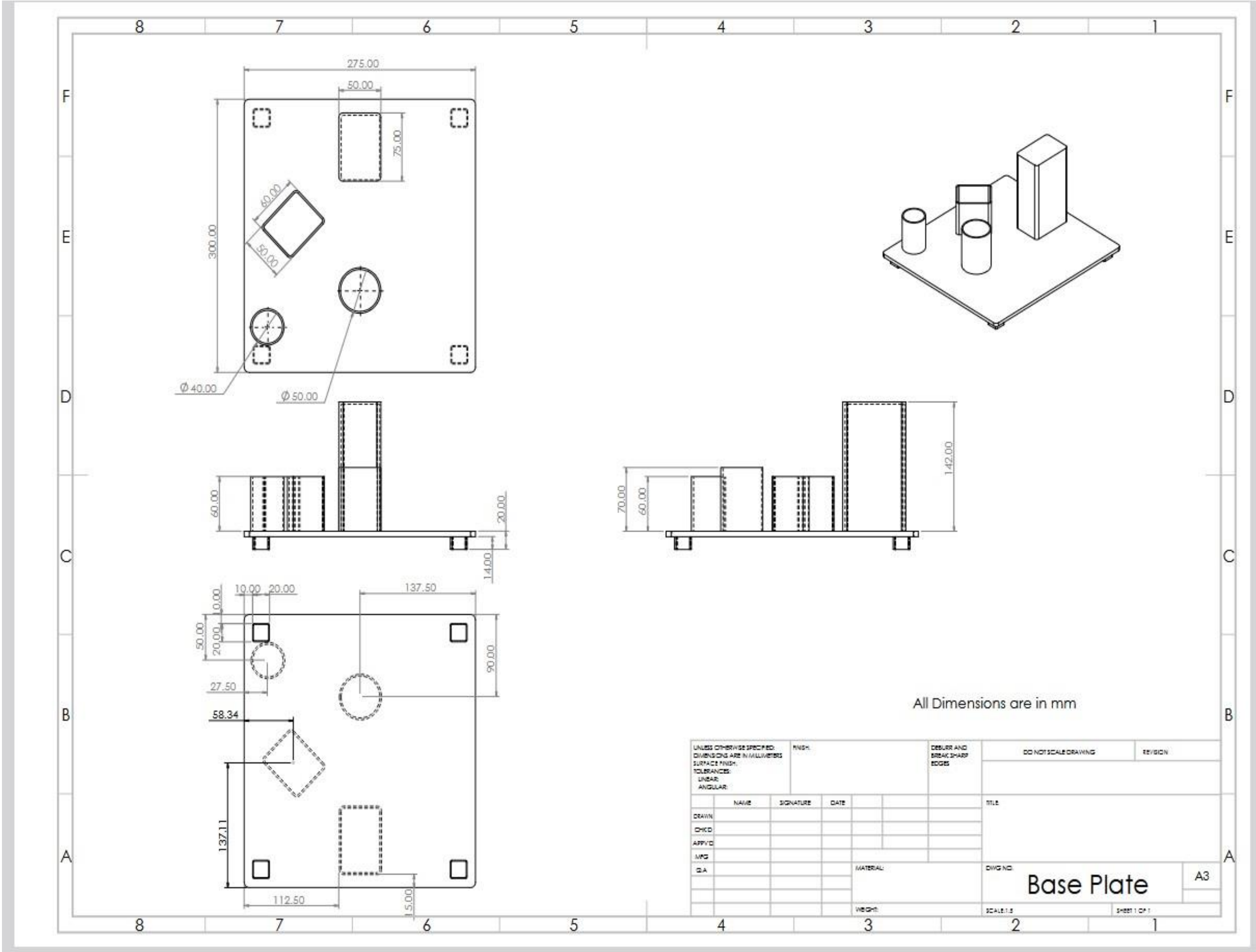
Wooden plates are relatively inexpensive compared to metal or plastic alternatives. Their affordability makes them a popular choice for temporary or disposable applications.

Eco-Friendly:

Being a renewable and biodegradable material, wood is an environmentally friendly choice. Wooden plates are often made from sustainably sourced timber, reducing environmental impact.

Customizability and Workability:

Wood can be easily cut, shaped, or joined, making wooden plates highly customizable. They are commonly used in patterns for casting processes and molds in manufacturing.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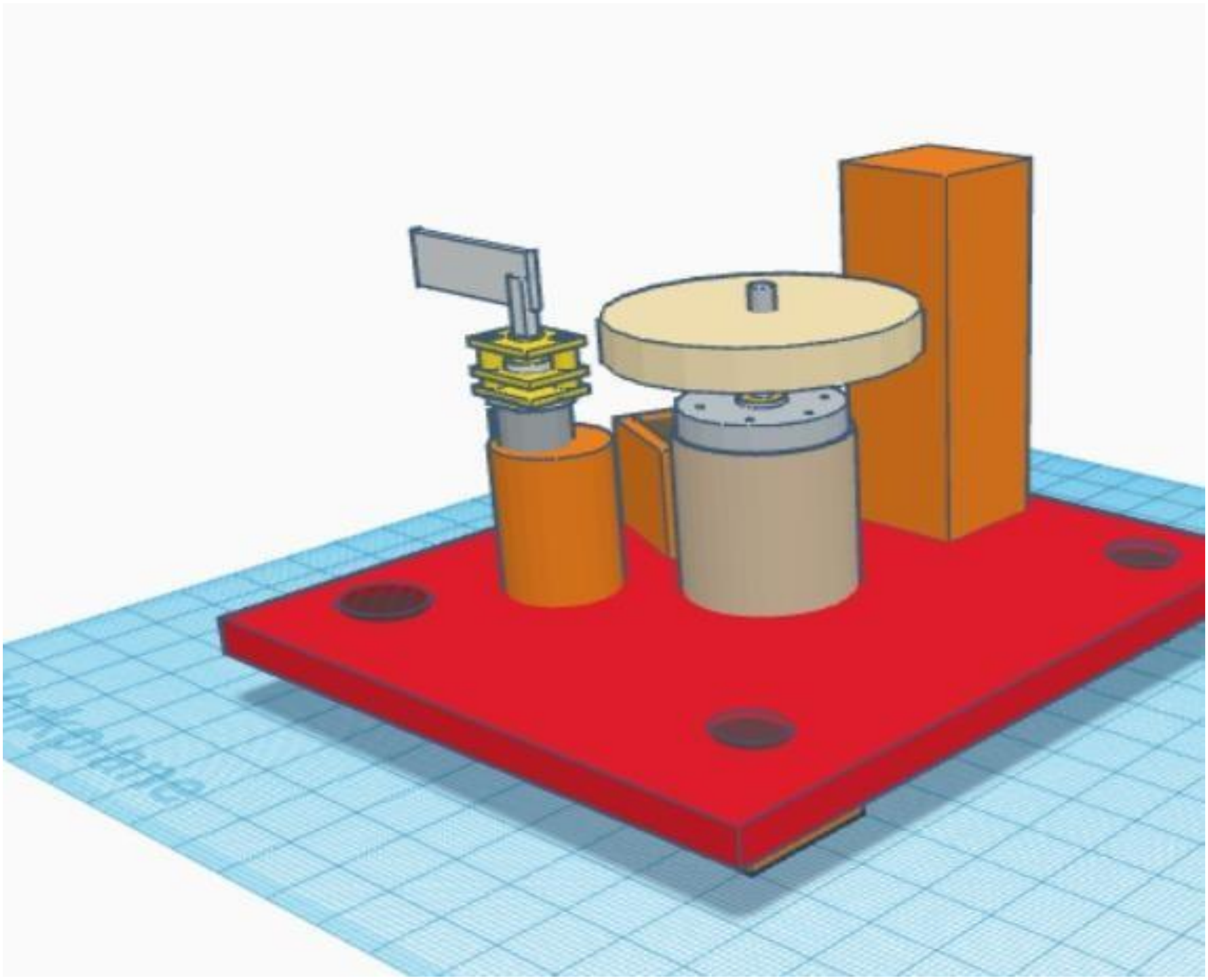
137.11
112.50
15.00
All Dimensions are in mm
Base Plate
A3

2D MODEL



3D MODEL

CHAPTER 8

COST ESTIMATION

SL NO	PARTICLES	AMOUNT
1	OTHER ALLOWANCES	500
2	FABRICATION COST	200
3	WELDING	500
4	OVERHEAD CHARGES	500
5	MATERIAL COST	700
6	MANUFACTURING COST	250
	TOTAL COST	2650

CHAPTER 9

WORKING PRINCIPLES

The working principle of the chip removal system for a gear hobbing machine involves the systematic collection, transport, and disposal of metal chips generated during the machining process. As the cutting tool removes material from the workpiece, the chips are directed towards a designated collection zone using gravity or cutting fluid flow. From there, a conveyor or auger mechanism transports the chips to a disposal or recycling unit. Simultaneously, the system may incorporate coolant separation techniques to recover and recycle cutting fluids, reducing wastage. Automation and sensors can be integrated to monitor and manage chip removal in real-time, ensuring uninterrupted machine operation and maintaining workplace cleanliness.

CHAPTER 10

RESULT

The chip removal system for the gear hobbing machine was successfully designed and implemented, achieving its primary objectives of efficient chip management and improved operational performance. The system demonstrated effective collection and transportation of chips from the cutting zone, significantly reducing machine downtime and maintenance requirements. Coolant recovery and recycling mechanisms reduced wastage and enhanced sustainability.

CHAPTER 11

CONCLUSION

1. Material Removal Analysis: Quantify chip generation during gear hobbing, considering material type, cutting speed, and feed rate.

2. System Design: Plan the structure of the chip removal mechanism, including conveyors, filters, and coolant separators.

3. Automation: Incorporate automated solutions such as sensors and programmable controllers for real-time chip monitoring and disposal.

4. Material Handling: Ensure smooth transport of chips from the cutting zone to the disposal or recycling unit.

5. Coolant Management: Address coolant recovery and separation from chips to reduce wastage and contamination.

6. Environmental Considerations: Design the system to comply with environmental regulations and promote sustainable manufacturing practices.

7. Safety Measures: Include safeguards to prevent chip build-up, which can lead to overheating or machine wear.

8. Cost Analysis: Evaluate the cost-benefit ratio, considering installation, maintenance, and operational expenses.

BIBILIOGRAPHY :