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Material Elevation System Using a Rotating Helical Screw within a Cylindrical Casing

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Abstract: This paper presents the comprehensive design, development, and performance analysis of a material elevation system based on the principle of a rotating helical screw within a cylindrical casing. Known as a screw conveyor, this system is widely utilized for the efficient transportation of bulk materials across industries such as agriculture, food processing, construction, and waste management. The primary aim of this research is to design a reliable, cost-effective, and energy-efficient system suitable for various industrial applications. The study delves into the mechanical principles governing the system, key design considerations, material selection, fabrication techniques, and performance testing under diverse conditions. A detailed literature review explores the evolution of screw conveyors and highlights the gap this research aims to bridge. The research also includes theoretical modeling, CAD simulations, and prototype development. Results indicate that the proposed system is highly efficient, with minimal spillage and low power consumption, making it an ideal solution for modern material handling challenges.

Keywords: *Helical Screw, Material Elevation System, Cad Simulation.*

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I. INTRODUCTION

Material handling systems are integral to the productivity and efficiency of various industrial processes. The ability to move raw materials or products from one point to another in a controlled and reliable manner is essential in industries ranging from agriculture to construction. Among the different types of material handling systems, the screw conveyor stands out due to its simplicity, versatility, and efficiency. A screw conveyor consists of a helical screw blade, also known as a flighting, that rotates within a stationary cylindrical casing. As the screw rotates, material is pushed along the casing, either horizontally, vertically, or at an inclined angle.

This research investigates the potential of screw conveyors as a material elevation system with a focus on scalability, energy efficiency, and suitability for small to medium-sized enterprises (SMEs). The goal is to develop a prototype that meets industrial standards while being affordable and easy to maintain. This paper presents a systematic approach to designing such a system, including requirement analysis, conceptual design, fabrication, and testing. The research also emphasizes the importance of selecting appropriate materials and optimizing design parameters to ensure durability and efficiency.

II. LITERATURE REVIEW

Screw conveyors have been in use for centuries, with early designs attributed to Archimedes, who developed the Archimedean screw for water lifting. Modern adaptations have transformed this basic principle into highly engineered systems used in agriculture, manufacturing, mining, and construction.

- *Historical Background:*

The screw conveyor traces its origin to ancient Greece, where Archimedes invented the Archimedean screw around 250 BCE for lifting water. Over centuries, this principle has been adapted to transport dry materials. The modern screw conveyor is a versatile and reliable system used in many sectors, offering the ability to move materials with controlled flow and minimal human intervention. Figure 1 shows the cad generated drawing of the screw conveyor.

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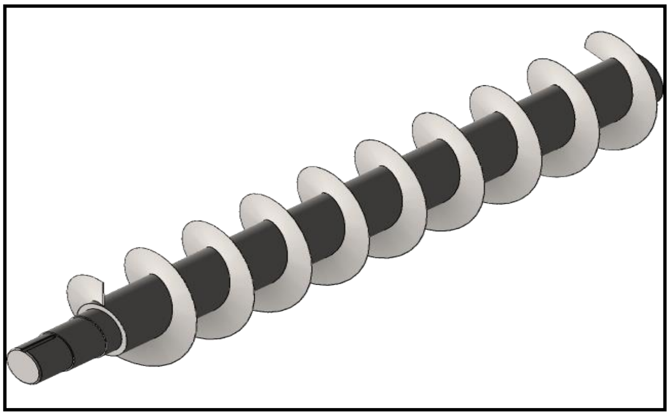
Fig 1 Screw Conveyor

➢ *Modern Applications:*
Today, screw conveyors are used in industries such as:

- *Agriculture:*
Transporting grains and animal feed

- *Food processing:*
Handling powders like flour and sugar

- *Waste management*:
Moving sludge and semi-solid waste

- *Construction:*
Conveying sand, cement, and other bulk materials

➢ *Prior Research:*
Studies such as Roberts (1999) and Owen et al. (2003) focused on the flow behavior of granular materials in screw conveyors. Their work established correlations between screw speed, pitch, diameter, and flow rate. Other researchers have investigated wear resistance, energy efficiency, and system optimization (e.g., Yu & Arnold, 1997).

➢ *Research Gap:*
Despite the extensive research, there is a lack of low-cost, customizable designs suitable for small- and medium-scale industries, particularly in developing regions. This study aims to fill that gap by presenting a scalable, efficient, and easy-to-maintain screw conveyor system.

III. METHODOLOGY

The methodology involves the following steps:

➢ *Requirement Analysis:*
Identifying the types of materials to be handled and the required throughput.

➢ *Design Calculations:*
Determining screw diameter, pitch, rotational speed, and casing dimensions.

➢ *Material Selection:*
Choosing materials for the screw and casing based on wear resistance, strength, and cost.

➢ *Fabrication:*
Constructing the screw and casing using machining and welding techniques.

➢ *Assembly*:
Integrating motor, gearbox, bearings, and supports.

IV. SYSTEM DESIGN

➢ *Design Parameters:*

- *Screw Diameter:* 55 mm
- *Pitch:* 55 mm (equal to diameter)
- *Length:* 2 ft
- *Rotational Speed:* 60 RPM
- *Material:* PVC for the screw & casing

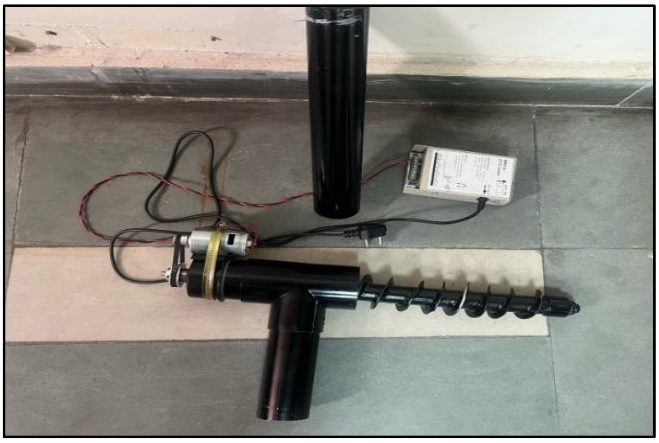
Fig 2 Top View of Model Developed

➢ *Power Requirement:*
The power required to drive the screw is calculated using standard engineering formulas considering friction, load weight, and angle of inclination.

➢ *CAD Modeling:*
3D models were created using Solid Works to simulate the design and validate clearances, tolerances, and material flow.

V. FABRICATION AND ASSEMBLY

The screw was fabricated by welding helical flights onto a central shaft. The casing was made from rolled stainless steel sheets. A motor and gearbox were mounted to drive the screw. Bearings were used to support the shaft and reduce friction. The entire system was mounted on a frame for stability.

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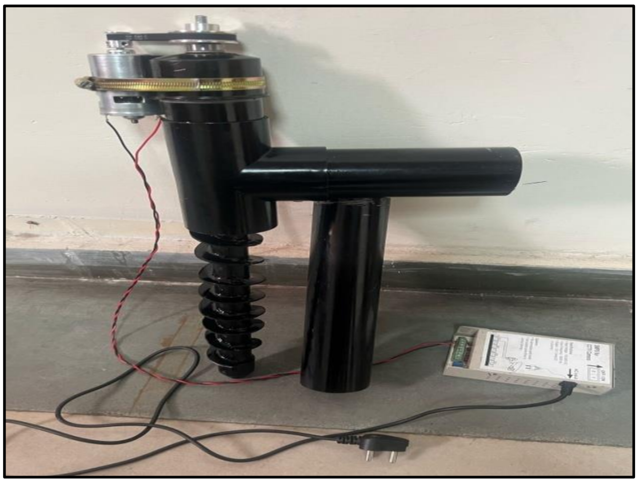

Fig 3 Front View of Model Developed

VI. TESTING AND RESULTS

- *Test Materials:*
- Sand
- Rice grains
- Water

- *Results Summary:*
- *Throughput:*
  10–20 kg/min depending on material

- *Power:*
  0.75 kW average

- *Noise/Vibration:*
  Within acceptable limits

The system performed reliably under various conditions and proved suitable for different material types.

I. DISCUSSION

The results validate the efficiency and reliability of the system. The enclosed design reduced spillage and prevented contamination. The screw diameter and pitch were effective for the target materials. However, for sticky or abrasive materials, modifications such as Teflon coating or hardening may be required.

Energy consumption was found to be minimal for the output achieved. The system's modular nature allows for scalability and customization based on industrial requirements. Maintenance needs were also low, primarily involving periodic lubrication and inspection.

II. APPLICATIONS

The developed system can be used in:

- *Agriculture:*
  Elevating grains in silos or mills

- *Construction:*
  Cement and sand transfer

- *Food Industry:*
  Flour and sugar transport

- *Waste Management:*
  Sludge and semi-solid waste movement

- *Mining:*
  Ore and powder transport

VII. CONCLUSION

This study successfully designed, developed, and tested a material elevation system using a rotating helical screw within a cylindrical casing. The system is efficient, cost-effective, and suitable for a range of industrial applications. With minor modifications, it can be adapted for challenging materials and larger-scale operations. Future work will focus on automation and integration with sensors for smart material handling systems.

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