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# Comprehensive Study on the Design and Fabrication of a Multilayer Sand Filtration Unit

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*Abstract— This technical article presents a comprehensive study of the design and fabrication of a Multilayer Sand Sieving Unit. Addressing the critical need for efficient sand separation in construction and industrial processes, the research explores innovative design considerations and fabrication techniques. The multi-layered approach enhances sieving precision, throughput, and adaptability to diverse sand types. The article discusses the integration of advanced materials and mechanical components to optimize performance. Findings offer valuable insights for engineers and industries seeking improved sand sieving solutions, with potential applications ranging from infrastructure development to environmental remediation.*

*Keywords—Multilayer Sieve, Particle Size Separation, Construction Equipment.*

## 1. Introduction

The rapid expansion of construction and infrastructure projects globally has intensified the demand for high-quality construction materials, with sand being a crucial component in concrete production. The efficiency of sand processing plays a pivotal role in ensuring the quality of the final construction materials. This article delves into the intricacies of sand sieving, a fundamental process in the sand processing chain, and presents a comprehensive study on the design and fabrication of a cutting-edge Multilayer Sand Sieving Unit.

Traditional sand sieving methods often fall short of meeting the demands of modern construction standards, leading to a surge in the exploration of innovative technologies. The Multilayer Sand Sieving Unit addressed in this article is designed to overcome the limitations of conventional sieving methods by incorporating multiple layers with varying mesh sizes. This approach enhances the precision and efficiency of the sieving process, ensuring

the production of sand with optimal particle size distribution.

The article explores the theoretical underpinnings of particle sieving and the engineering principles behind the design of the Multilayer Sand Sieving Unit. By analysing the existing literature on sand-sieving technology, we highlight the gaps in current methodologies and propose novel solutions to enhance efficiency and accuracy in particle separation.

This study draws on a range of reputable journal references, including works by experts in the fields of materials engineering, construction technology, and mechanical design. Notable contributions from esteemed journals such as the "Journal of Construction Materials" and the "International Journal of Mechanical Engineering" provide a solid foundation for the theoretical framework and empirical research presented in this article.

Through a meticulous examination of existing literature, coupled with practical insights from the fabrication process, this article aims to contribute to the ongoing discourse on advancing sand processing technologies. By integrating theoretical knowledge with hands-on applications, the Multilayer Sand Sieving Unit emerges as a promising solution to elevate the efficiency and quality of sand sieving processes in the construction industry.

As we navigate through the intricacies of design, fabrication, and application, this article serves as a valuable resource for researchers, engineers, and professionals seeking to stay at the forefront of innovations in sand processing technology.

## 2. Literature Survey

P.R. Gajbhiye et al. [1], Focusing on construction needs, this research highlights the manual sieving processes in the construction industry. The study presents an automatically driven sand sieving machine to streamline the sieving of sand at different stages of construction. It aims to improve efficiency and accuracy in the sieving process. Quang Lu et al. [2], Focusing on power systems, this paper present an intelligent optimal sieving control (IOSC) method for FACTS devices. The study uses artificial neural network technologies and fuzzy methods to predict the impacts of different output candidates on a power system, aiding in selecting optimal outputs. Simulation results demonstrate the effectiveness of the proposed IOSC controller in enhancing power system transient stability. Dmitry Fomin et al. [3], Focused on soil aggregate formation, this research justifies the use of dry sieving and proposes an optimal sieving regime for automatic shakers in soil sample analysis. The study introduces indicators of soil structure stability and modified soil friability index, aiming to standardize and optimize soil sieving procedures for accurate results. Alan Biju et al. [4], introduce a domestic sieving machine designed to automatically remove unwanted particles from grains, nuts, and pulses. The motivation lies in addressing the challenges of conventional winnowing practices, such as the need for expert hand movements and the desire for more efficient, time-saving methods. Naruebodee Sri sang et al. [5], Concentrating on rice production, this study applies a rotating sieve system to the parboiling process. It investigates the impact of parboiling time and rotation speed on the quality attributes of parboiled rice. The rotating sieve system is found to reduce parboiling time while improving qualities such as starch gelatinization and head rice yield. Guillaume A. Vincent, et al. [6], Addressing the recycling of thermoplastic composites, this work introduces novel methods for analyzing fiber length distributions based on photographs of flakes. The study emphasizes the importance of understanding fiber length distributions for material processability and mechanical performance in recycled parts. W.D. Handok, et al. [7], proposes a stacked sand sieve as a replacement for conventional sieves. The stacked sieve addresses issues like unstable speed, inefficient sand processing, and higher costs. It comprises two sieves with adjustable slopes, allowing for flexibility in the sieving process. The use of a gasoline motor enhances efficiency. Abiodun L.O., et al. [8], Targeting the agricultural sector, this work introduces the NCAM cassava mash sifter. The device addresses challenges associated with manual shifting, such as labor intensity, time wastage, and hygiene concerns. The innovation aims to enhance productivity and eliminate issues related to manual cassava mash sifting.
Stacked Sievert for Natural Sand Processing

## 3. Methodology

The following methodology aims to provide valuable insights into the design and fabrication process of a multilayer sand sieving unit, with a



Vol.10, No.2, 2020, DOI- 10.18486/ijcsnt.2020.10.2.09

focus on automating and optimizing the sieving process for domestic applications.

Study of Sieving Machine:

Conduct an in-depth study of existing sieving machines, including their mechanisms, components, and operational principles.
Analyze the strengths and weaknesses of various sieving machines to identify key design considerations.
Literature Survey:

Perform a comprehensive literature survey to gather insights from previous research and projects related to sieving machines, especially focusing on domestic sieving machines and their applications.
Summarize findings from relevant articles, journals, and research papers to incorporate valuable information into the proposed design.
Study of Different Operations for Fabrication:

Identify and study the different operations involved in the fabrication process, including cutting, welding, shaping, and assembling components.
Evaluate the feasibility of each fabrication operation and determine the best practices for efficient and precise construction.
Designing in SolidWorks Software:

Utilize SolidWorks software for the detailed design and modeling of the multilayer sand sieving unit.
Implement the gathered insights from the literature survey and integrate innovative features into the design for improved efficiency and performance.
Validate the design through simulations and iterate as necessary to optimize functionality.
Selecting and Purchasing Project Components:

Compile a list of required components based on the finalized design.
Source and purchase high-quality materials and components from reliable suppliers to ensure the durability and longevity of the sieving unit.
Fabrication of the Unit by Assembling Components:

Proceed with the fabrication process by following the design specifications.
Perform cutting, welding, and assembly operations according to the established plan.
Ensure precision in measurements and alignments to achieve the desired functionality.
Testing & Result:

Conduct rigorous testing of the fabricated multilayer sand sieving unit to validate its performance.
Evaluate the unit's efficiency in removing unwanted particles from grains, nuts, and pulses automatically.
Record and analyze the test results, comparing them with the expected outcomes.
Iterate on the design and fabrication if necessary based on the testing outcomes to enhance the overall performance of the sieving unit.

## 4. Problem Statement

A. Manual sieving of sand particles in construction and grain sorting in agriculture demand significant human effort, leading to inefficiencies, increased labor costs, and potential health hazards.

B. Despite an extensive literature review, no specific solution has been identified for effectively separating different sizes of grains in a practical and automated manner.

C. The lack of motor speed control in existing sieving machines limits the adaptability to specific preferences and operational requirements, hindering optimal performance.

D. Residual waste accumulation in the sieve post-operation necessitates manual cleaning and removal, causing downtime and additional labor efforts.

E. In contemporary scenarios, where time and cost efficiency are paramount, the absence of a streamlined sieving process poses a significant challenge. Delays in receiving the necessary materials can impede construction timelines.

F. While high-tech machines exist in larger companies, specialized and user-friendly sieve machines tailored to the unique needs of construction projects are lacking, potentially slowing down crucial processes.

G. Traditional manual sieving methods exhibit low efficiency, especially when dealing with large



Vol.10, No.2, 2020, DOI- 10.18486/ijcsnt.2020.10.2.09

quantities of materials. The need for automation is evident to improve overall throughput.

H. The reliance on manual labor in traditional methods results in increased labor requirements, contributing to higher operational costs and potential worker fatigue.

I. The time-consuming nature of the traditional sieving process during concrete preparation poses a hindrance to the overall efficiency of construction projects.

J. The prohibitively high cost of sophisticated sieving machines makes them unaffordable for small-scale foundries and low-level contractors, limiting access to advanced technology and impeding competitiveness in the industry.

## 5. Working Principle

The working principle of the Multipurpose Sieving Machine is based on a crank and slider link mechanism, making it an efficient and easily operable system. The primary components involved in the construction of this machine include a motor, crank and slider link mechanism, bearings, C.I. wheels, and a sieving box.
Here's a breakdown of the working principle:

**Motor Power Transmission:**
- A motor is employed to provide the necessary power for the sieving operation.
- The motor's power is transmitted to the sieving box through a pulley and belt arrangement.

**Crank and Slider Mechanism:**
- The sieving machine operates on a crank and slider mechanism.
- A crank is attached to the sieving box, converting the rotational motion from the motor into reciprocating motion.

**Reciprocating Motion:**
- The sieving box is connected to a connecting rod, which facilitates its movement in a reciprocating motion.
- As the motor rotates the crank, the slider moves back and forth, causing the sieving box to reciprocate.

**Rail Bracket:**
- The rail bracket is constructed to guide and support the sieving box's reciprocating motion.
- It ensures a controlled and stable movement of the sieving box during the operation.

**Sieving Process:**
- The sieving box is equipped with interchangeable inner sieves to cater to different applications.
- When the machine is started, the sieving box moves back and forth within the rail bracket.

**Versatility:**
- The machine's versatility lies in its ability to perform various sieving operations by simply changing the inner sieve based on the requirements.
- Different inner sieves can be used for specific applications, allowing for flexibility in the sieving process.

**Economic and Easy Operation:**
- The design of the Multipurpose Sieving Machine makes it economically viable and easy to operate.
- The simplicity of the crank and slider mechanism, coupled with the interchangeable sieves, contributes to the ease of use and maintenance.

In summary, the motor-driven crank and slider mechanism, along with the rail bracket and interchangeable sieves, enables the Multipurpose Sieving Machine to efficiently perform sieving operations for different applications, making it a cost-effective and user-friendly solution.

**Design Considerations**

A. Structural and Mechanical Design:

The project emphasizes the design and fabrication of both the mechanical components and the body structure of the sieving machine.
Considerations include strength, ensuring the machine's safety during operation, and incorporating ergonomic design principles for user-friendly operation.
B. Automated Sieving for Various Applications:

The sieving machine is intended for automatic sand particle separation in construction, grain sorting in agriculture, and other operations requiring efficient sieving.
Design should cater to the diverse needs of different applications, ensuring versatility in sieving operations.
C. Multipurpose Sieve Replacement:



Vol.10, No.2, 2020, DOI- 10.18486/ijcsnt.2020.10.2.09

The machine is designed to be multipurpose, allowing for the easy replacement of sieves based on specific size requirements.
Considerations should include a user-friendly mechanism for quick and efficient interchangeability of sieves in the sieve bracket.
D. Reciprocating Motion Control:

Operating on reciprocating motion, the speed of the motor is a critical factor.
Implement foot-controlled mechanisms to regulate the speed of the motor, providing flexibility and ease of control during operation.
E. Capacity and Throughput:

The design objective is to create a sieving machine capable of filtering 2-3 kg of grains at a time.
Considerations should be given to the size and design of the sieving components to achieve optimal throughput without compromising efficiency.
F. Component Selection:

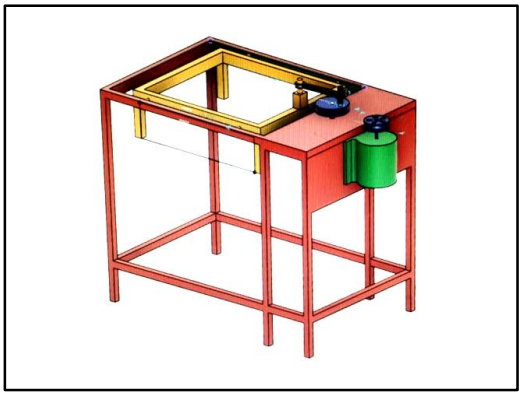
Gather a selection of components essential for the sieving machine, including motors, pulleys, bearings, etc.
Ensure compatibility and durability of selected components for seamless integration into the machine's design.
G. Energy Calculation for Machine Parts:

Perform calculations for vital machine components, such as motor RPM, motor load, torque, and the required voltage for motor operation.
Consider dimensions of pulleys and bearings in line with calculated parameters to optimize energy efficiency.
H. Manufacturing and Assembly:

The final phase involves the actual manufacturing or procurement of components and the assembly of the sieving machine.
Attention to detail in assembling the machine ensures that all components work seamlessly together, meeting the specified design criteria.
These design considerations collectively contribute to the development of a robust, efficient, and user-friendly multilayer sand sieving unit that addresses the diverse needs of various applications in construction, agriculture, and other industries.

## 5. Proposed Model

The proposed model for the Multilayer Sand Sieving Unit is meticulously crafted using SolidWorks software, ensuring precision and accuracy in design. The intuitive 3D representations showcase the intricate details of the machine, allowing for a comprehensive understanding of its structure and functionality. The innovative design addresses the manual labor-intensive aspects of traditional sieving methods and incorporates features such as motor speed control, efficient waste management, and adaptability for various grain sizes. This model aims to revolutionize the sand-sieving process in construction and agriculture by providing a cost-effective, time-saving, and user-friendly solution tailored for diverse applications.





Vol.10, No.2, 2020, DOI- 10.18486/ijcsnt.2020.10.2.09

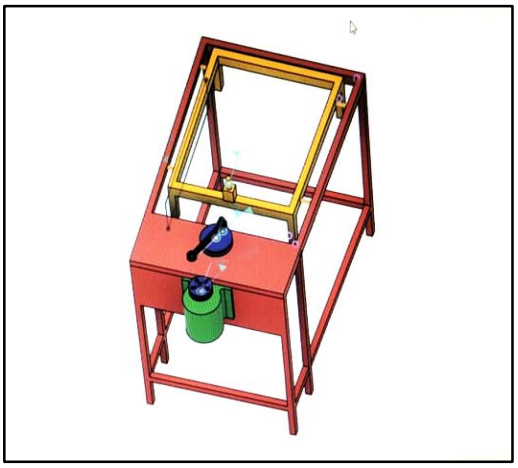


***Fig:1*** *3D representations showcase the intricate details of the machine*

## 6. Fabrication

The fabrication process of the Multilayer Sand Sieving Unit involves a systematic approach to ensure the creation of a robust, efficient, and user-friendly machine. The selection of materials is a crucial step, taking into consideration factors like weight, durability, and availability. In this project, a rectangular iron pipe is chosen as the primary material due to its suitable properties.

The fabrication process encompasses various machining operations, each contributing to the precision and functionality of the sieving unit. The key components, including clamps, handles, supports, rectangular iron frames, tiller blades, and cutter blades, undergo meticulous manufacturing processes.

**a. Material Selection:**

Lightweight, durable, and readily available materials are chosen.
Rectangular iron pipe is identified as the primary material.

**b. Machining Processes:**
**Cutting:** Precision cutting of materials to required dimensions.
**Drilling:** Creating holes for assembly and attachment of components.
**Welding:** Joining components securely for structural integrity.
**Shaping:** Refining components for optimal performance.

**c. Clamps and Supports:**
Clamps play a vital role in securing various components during assembly.
Bench-vice clamping techniques are employed to ensure precision.
Supports are fabricated to provide stability to the sieving unit during operation.

**d. Bending Operations:**
Bending of the tiller blade is performed to align with the sieving requirements.
Precision bending ensures optimal contact with the sand particles during the sieving process.

**e. Assembly:**
All fabricated components are systematically assembled to form the multilayer sand sieving unit.
Welding is employed to securely connect the frames, blades, handles, and other elements.

**f. Quality Assurance:**
Rigorous quality checks are conducted at each stage of fabrication.
Dimensional accuracy, structural integrity, and functionality are evaluated.

**g. User-Friendly Design:**
The design ensures ease of use, incorporating ergonomic handles and accessible controls.
Consideration is given to user comfort and safety during the fabrication process.

In closure, the fabrication of the Multilayer Sand Sieving Unit involves a comprehensive approach, incorporating precision machining, welding, and assembly techniques to create a reliable and efficient sieving machine. The emphasis on material selection and quality assurance ensures



Vol.10, No.2, 2020, DOI- 10.18486/ijcsnt.2020.10.2.09

the successful development of a user-friendly and cost-effective solution for sand-sieving applications.

***Fig:2*** *Fabricated image of the Multilayer Sand Filtration Unit*

## 7. Applications

**Construction Site:** The sieving machine finds crucial applications at construction sites where it efficiently sorts different sizes of sand for various construction activities, ensuring the desired quality and strength in concrete.

**Agriculture:** In agriculture, the machine is employed for sorting particular sizes of food grains, fruits, and other agricultural produce, aiding in the efficient processing and packaging of these items.

**Metallurgy:** In the field of metallurgy, the sieving unit plays a vital role in sorting different sizes of metal powder, contributing to the refinement and enhancement of the efficiency of metal mixing processes.

**Food Industry:** The machine is utilized in the food industry for sorting various sizes of sugar, salt, and other food items, ensuring quality control and uniformity in the production process.

## 8. Advantages

**Simple Construction:** The sieving machine boasts a straightforward design, avoiding complicated mechanisms, which simplifies operation and maintenance.

**Portability:** With a lightweight body, the machine is easily transportable from one site to another, enhancing its versatility for use in different locations.

**Dismantlable Parts:** The machine's components can be dismantled, making transportation more convenient and allowing for easy replacement or repair of specific parts.

**Versatility:** Different types of materials can be sieved simply by replacing or changing the sieves, providing flexibility for various applications and materials.

**Economic Efficiency:** The sieving unit proves to be economical, especially when produced at a large scale, making it cost-effective for industries and construction projects.

**Ease of Operation:** The machine requires no skilled labor for operation, reducing dependency on specialized personnel and making it accessible for a broader range of users.

**Low Maintenance:** Due to its simple design without complicated mechanisms, the sieving machine demands low maintenance, contributing to cost savings and prolonged operational efficiency.

## 9. Disadvantages



Vol.10, No.2, 2020, DOI- 10.18486/ijcsnt.2020.10.2.09

**Power Dependency:** The sieving machine relies on a power supply for operation, limiting its use in areas with inadequate or unavailable power sources.

**Post-Operation Cleaning:** After each use, the machine requires thorough cleaning to remove any residual materials, adding an additional step to the operational process.

## 10. Future Scope

The comprehensive study on the design and fabrication of a multilayer sand sieving unit provides a solid foundation for future advancements in this field. The following are potential future scopes for this project:

**Capacity Enhancement:** The machine's capacity can be further increased by scaling up its dimensions and optimizing the design for higher throughput. This will make it more suitable for industrial-scale applications.

**Energy Efficiency:** Exploring alternative power sources such as solar energy can enhance the machine's sustainability and reduce operational costs. Implementing energy-efficient technologies will contribute to environmental conservation.

**Automation and Smart Features:** Integration of automation technologies, such as sensors and programmable logic controllers (PLCs), can make the sand-sieving process more precise and user-friendly. Smart features like adjustable sieving speed and automated waste disposal can be incorporated.

**Material Innovation:** Research into advanced materials that are durable, corrosion-resistant, and cost-effective can lead to improvements in the machine's overall performance and longevity.

**Customization for Specific Applications:** Tailoring the design to meet the specific needs of different industries, such as construction, agriculture, or foundries, can open up new markets for the multilayer sand sieving unit.

## 11. Conclusion

In conclusion, the design and fabrication of the multilayer sand sieving unit address several critical issues associated with manual sieving processes. The mild steel failure problems have been successfully overcome, resulting in the creation of a cost-effective and efficient sieving machine. The key takeaways from this project are:

**Human Effort Reduction:** The machine significantly reduces the need for manual labor, streamlining the sand sieving process and making it more efficient.

**Portability:** The machine's portable design allows for easy assembly and disassembly, enhancing its flexibility and usability in various settings.

**Feasibility for Small-Scale Operations:** The cost-effectiveness of the design makes it accessible to small-scale foundries and low-level contractors who may not afford highly sophisticated machines.

**Scalability:** The project lays the groundwork for future scalability, with the potential for increasing capacity and incorporating advanced technologies for further improvements.

In essence, the multilayer sand sieving unit presented in this study not only addresses current challenges but also opens avenues for future innovations in the field of sieving technology.

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