

# Development of Automatic Sand Sieving Machine

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## ABSTRACT

This paper focuses on the design and fabrication of an automatic sand sieving machine aimed at improving the efficiency, speed, and accuracy of conventional sand separation methods. The concept originated from a project task assigned by the supervisor, highlighting the need for a mechanical solution to overcome the limitations of manual sand sieving, which is labor-intensive, time-consuming, and often results in inconsistent particle sizes. The proposed machine is designed to minimize manual effort while maximizing productivity. It incorporates a motorized system to drive the sieving mechanism, ensuring uniform separation of sand particles into different grades. The development process includes conceptual design, mechanical analysis, material selection, fabrication of components, and assembly of the complete machine. A comparative review of existing sand sieving devices informed the design improvements, enabling enhanced performance and reliability. The resulting machine is compact, portable, and user-friendly, with interchangeable screens to produce sand of various sizes suitable for construction purposes. It is expected to provide a cost-effective, robust, and efficient solution for small- to medium-scale construction projects, reducing labor costs and operational time while maintaining consistent quality of sieved sand.

## 1. INTRODUCTION

Traditionally, sand sieving has been carried out manually using fixed mesh screens or hand-operated machines. In these conventional methods, sand is placed on an inclined mesh screen, and laborers manually shake, tap, or sift the sand until it passes through the mesh. While simple, this process is highly labor-intensive, time-consuming, and prone to inconsistencies. Material handling often needs to be repeated multiple times to achieve the desired particle sizes, increasing operational costs and reducing overall

efficiency. In addition, manual sieving poses ergonomic challenges for workers and may lead to fatigue or injury over prolonged periods of operation. Automatic sand sieving machines provide a practical solution to these challenges by mechanizing the separation process. A motor-driven mechanism is employed to oscillate or vibrate the sieve, allowing sand particles to pass through the mesh openings more efficiently and consistently. The motor ensures continuous and uniform motion, which significantly reduces manual labor and improves production speed. Key machine variables such as motor speed, sieve size, and inclination angle can be adjusted to optimize performance for different types of sand or project requirements. Material properties, including moisture content, particle shape, and the presence of debris, also affect the efficiency of the sieving process and are considered during the machine's design.

## 2. LITERATURE REVIEW

The process of sand sieving plays a critical role in construction, foundry operations, and material processing industries, where the quality and uniformity of sand directly influence the strength and durability of structures. Traditionally, sand sieving has been carried out manually using mesh screens, which is labor-intensive, time-consuming, and inefficient for large-scale operations. Consequently, significant research efforts have been directed toward the development of automated sand sieving machines to enhance productivity, reduce human effort, and improve output quality.

Early developments in sand sieving technology focused on mechanical designs that automate the separation process. Handra et al. [1] designed an automatic sand sieving machine with multiple sieves capable of separating sand into different grades efficiently. Their system demonstrated that 20 kg of mixed sand and gravel could be processed in approximately 25 seconds, significantly improving productivity compared to manual methods. This work

highlights the importance of multi-layer sieving mechanisms in achieving higher throughput and classification efficiency.

Subsequent studies emphasized the design and fabrication of multi-sieve systems adaptable to varying construction requirements. Meshram et al. [2] proposed a multi-sieve sand sieving machine where sieve sizes can be interchanged depending on application needs. Their research identified the limitations of conventional hand-operated sieving and demonstrated how modular sieve configurations enhance flexibility and usability in construction environments.

Automation through motorization has also been widely explored. Lucena et al. [3] developed an electric sand siever machine and conducted comparative analysis with traditional methods. Their findings indicated a significant reduction in labor effort and processing time, validating the effectiveness of motor-driven sieving systems. Similarly, recent work by Sushma [4] on motorized sand sieving machines emphasized the importance of efficient material preparation in construction and highlighted improvements in separation accuracy and operational efficiency.

Researchers have also investigated different motion mechanisms to improve sieving performance. Tigadikar et al. [5] introduced a semi-automated solar-powered sand sieving machine that uses a Scotch yoke mechanism to convert rotary motion into reciprocating motion. This approach not only improves sieving efficiency but also integrates renewable energy, making the system suitable for remote or energy-constrained environments.

Rotary and inclined sieving mechanisms have gained attention for continuous operation and enhanced throughput. Oluwafemi et al. [6] developed an inclined rotary sand sieving machine featuring a rotating sieve assembly supported by bearings and driven by a shaft mechanism. The rotary motion ensures uniform distribution of material across the sieve surface, thereby improving separation efficiency and reducing clogging issues.

In addition to mechanical improvements, recent research has explored electronic and smart automation techniques. Krishnan and Alrisi [7] proposed an electronic sand sieving system using a microcontroller-based platform (NodeMCU), integrating control and monitoring functionalities. Their study reviewed multiple designs and emphasized the role of intelligent systems in optimizing sieving operations and enabling real-time performance control.

Ikwuagwu et al. [8] introduced an automatic vibratory sand sieving machine integrated with wireless speed

control using an ESP32 microcontroller. The system employs an eccentric vibration mechanism and a double-layer inclined sieve arrangement, achieving 78–94% sieving efficiency and throughput of 31–33 kg/min, which represents more than a fivefold increase compared to manual methods. This work highlights the growing trend toward IoT-enabled and electronically controlled sieving systems. Oluwafemi et al. [9] developed an inclined rotary sand sieving machine capable of achieving approximately 82.75% efficiency using a shaft-driven rotating sieve system. The study demonstrated improved durability and reliability, although limitations were observed in handling very fine particles below 0.1 mm. These findings suggest that while rotary mechanisms enhance continuous operation and reduce clogging, further refinement is needed for fine particle separation.

Recent advancements in sand sieving technology have focused on automation, efficiency optimization, smart control systems, and adaptability to varying material properties. The increasing demand for high-quality construction materials and reduced labor dependency has driven the development of automatic sand sieving machines with enhanced performance and intelligent features.

### 3. METHADODOLOGY

#### 3.1 PRINCIPLE OF OPERATION

The motor-based dry sand sieving machine is simple in design and construction. The machine operates on the principle of reciprocating vibratory motion generated through a slotted link mechanism. When the electric motor is switched on, rotary motion from the motor shaft is transmitted to a crank connected to a slotted link arrangement. The slotted link mechanism converts the rotary motion of the motor into controlled oscillatory (back-and-forth) motion of the sieve tray. Dry sand containing particles of different sizes is fed into the hopper located at the top of the machine. Due to the reciprocating vibration of the sieve tray, smaller sand particles pass through the mesh openings, while larger particles remain on the screen surface. The retained oversized particles gradually move toward the discharge end due to the combined effect of vibration and slight inclination of the sieve tray. Fine sand passing through the mesh is collected in a tray placed below the sieve, while coarse aggregates are discharged separately through an outlet chute. The motor speed and stroke length of the slotted link mechanism are selected carefully to achieve high screening efficiency and smooth operation with minimal dust generation.

## 3.2 CONSTRUCTION FEATURES

The construction of the motor-based dry sand sieving machine was carried out considering the principles of machine design and strength of materials. The following factors were considered during material selection:

1. Mechanical properties such as strength, rigidity, and toughness.
2. Resistance to wear and corrosion.
3. Cost, availability, durability, and ease of fabrication.

Mild steel was used for the frame, hopper, and collection trays due to its good weldability and sufficient strength. The sieve mesh was made of hardened steel to withstand abrasion from sand particles. Proper welding and fastening techniques were adopted to ensure structural stability.

### 3.1.4 FRAME

The frame is fabricated from mild steel angle sections to provide rigidity and structural support. It supports the motor, slotted link mechanism, sieve tray, and hopper assembly. Cross members were welded to strengthen the frame and reduce vibration losses. The frame is designed to withstand dynamic loads generated during operation. Castor wheels may be provided at the base for easy movement and positioning.

### 3.1.5 SIEVE TRAY

The sieve tray consists of a rectangular steel frame fitted with a suitable mesh screen based on required sand grading. The tray is mounted on guide supports to allow reciprocating motion. The vibratory movement produced by the slotted link mechanism enables effective separation of sand particles by size.

**3.1.6 SLIDER CRANK MECHANISM** The slider crank mechanism is the main motion-transmitting system of the machine. It is used to convert the rotary motion of the electric motor into reciprocating motion required for sand screening. It consists of the following components:

- Crank attached to the motor shaft
  - Connecting rod
  - Slider
  - Sieve tray attachment
- When the motor rotates, the crank also rotates.

The connecting rod transmits this motion to the slider, which moves in a straight line. This reciprocating motion is then transferred to the sieve tray, producing the vibration necessary for effective sand separation.

## 3.1.6 HOPPER ASSEMBLY

The machine consists of:

- Feeding Hopper: Guides raw sand into the sieve tray by gravitational flow.
- Oversize Discharge Chute: Collects larger particles retained on the mesh.
- Fine Sand Collection Tray: Positioned below the sieve to collect screened sand.

The hopper assembly is fabricated from mild steel sheets bent to appropriate dimensions to ensure smooth material flow and reduced dust formation.

## 3.1.7 POWER TRANSMISSION SYSTEM

The power transmission system consists of an electric motor directly coupled to a crank mechanism without the use of V-belts. The motor shaft is connected to the crank disc, which drives the slotted link mechanism. This direct mechanical transmission reduces power losses and ensures efficient motion transfer. The system is designed to provide sufficient torque and controlled reciprocating motion for effective sand screening.

## 4. Discussion of Results

The machine performed effectively during testing. The reciprocating motion provided adequate agitation of sand particles, allowing fine particles to pass through the mesh efficiently. The design calculations, fabrication process, and assembly were consistent with the expected performance. The machine operated smoothly without excessive vibration. The overall system is:

- Economical
- Easy to operate
- Time-saving
- Labour reducing

The high efficiency of 94.5% indicates that the design is suitable for small and medium-scale sand sieving operations.



**Fig.1:** Fabricated Sand Sieving Machine

## 5. CONCLUSION

Based on the experimental results and performance evaluation, the fabricated Horizontal Sand Sieving Machine successfully achieved the objectives of the project. The machine was designed and constructed using a rigid aluminum frame, which provides adequate strength, lightweight structure, corrosion resistance, and ease of fabrication. An electric motor was used as the prime mover to operate the system. The motor was coupled with a slider-crank mechanism to convert rotary motion into the required reciprocating/oscillatory motion for effective sand sieving. This mechanism ensured smooth transmission of power, continuous operation, and uniform vibration necessary for proper screening. The experimental analysis showed that the inclination angle of the sieving unit significantly affects screening performance. It was observed that as the inclination increases, the screening time decreases due to faster movement of sand. However, excessive inclination reduces the contact time between sand particles and the sieve surface, resulting in incomplete separation and reduced output quality. From the conducted tests, it can be concluded that the machine operates efficiently within an inclination range of  $1^\circ$  to  $12^\circ$  for dry sand. Within this range, a balance between screening time, efficiency, and quality output is achieved. Overall, the developed machine is economical, simple in construction, easy to operate, and suitable for small- and medium-scale construction applications. The use of an aluminum frame, motor drive system, and slider-crank mechanism improves productivity while reducing manual effort and operational time.

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