Fabrication and Analysis of Motorized Sand Sieving Machine

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ABSTRACT :

In today's world, construction becomes most common in anywhere. Which requires lot of materials like sand,cement,chips,bricks and water..etc which place an important role in building,bridges,roads constructions..etc whatever it may be the type of construction the construction of this all materials with superior quality gives strength to the specific construction one such task is preparation of material which is well known for its challenges the main team of this operation is to filter the sand like separation of fine grain sand from the unwanted particles of stones. To address this issue, we have Semi automatic motorised shaving machine. This machine is well suited for sieving the sand asrequired green size .Moreover it is cost- effective and efficient.

KEYWORDS :

Mild Steel table structure, wooden frame, sieve/mesh, Pitman rod, bearings and motor.

1. INTRODUCTION :

A semi automatic motorised sand sieving machine perform sand filtering from unwanted stones by vibrations of attached wooden frame. which is supported to the mild steel table structure by leaver and bearings setup. Which provides efficient work with minimum possible time along with minimising cost on labour force. It is user friendly. It works on the principle of converting rotary motion of the motor into reciprocating motion of the wooden frame with mesh. The energy to run the motor by means of external power supply from the domestic AC power supply. It can handle different green size by changing various mesh sizes attached to the wooden frame. It can bear approximately one or two kilograms of sand to provide interrupted performance.

2. LITERATURE REVIEW:

Efficient sand sieving is essential in the construction industry to ensure uniform material quality. Traditional manual sieving methods are slow, labor-intensive, and prone to inconsistencies. With increasing demand for automation in civil and mechanical applications, numerous researchers and engineers have explored the development of motorised sand sieving machines using various mechanisms, materials, and control systems.

Noronha et al. [1] presented an early design of a simple motorised sand sieving machine utilizing a crank mechanism, which significantly reduced human effort. Patil et al.

[2] further developed an electrically operated system that improved sieving efficiency and offered faster output. Their findings supportedthe feasibility of replacing manual sieving with semi-automatic systems using locally available materials.

Automated solutions have gained popularity in recent years. Yadav and Desale [3] proposed an automated sand filter using sensors and a scotch yoke mechanism. Mahesh and Hariharan [4] developed a vibratory system using an eccentric motor, demonstrating improved separation quality for various sand sizes. Similarly, Salunkhe et al. [6] introduced a dual-purpose machine for sand sieving and cement mixing, highlighting the importance of modular multifunctionality in construction equipment.

Studies by Patel and Joshi [5] emphasized the significance of vibration analysis in such systems, particularly when converting rotary motion into reciprocating action via cranks or connecting rods. Shinde [8] and Pandey & Das [9] explored how sieve amplitude and mesh size affect separation quality and concluded that optimal vibration frequency and mesh tension are essential for uniform filtering.

A number of other researchers have focused on structural improvements and mechanical efficiency. Pawar and Jadhav [7] conducted a comparative study between manual and motorised sieving, reporting a 60–70% increase in throughput with automation. Bagal et al. [10] integrated a scotch yoke-drivensystem, which provided smooth operation and reduced noise. Jain and Dhande [11] used a gear motor mechanism for consistent motion transfer, while Shah and Zope [15] used simulation analysis to improve the strength and durability of crank components.

Material selection and design guidelines are critical for ensuring longevity and safe operation. Standard texts such as Bhandari [16], Khurmi and Gupta [17], and Ghosh and Mallick [18] outline the fundamentals of machine design, stress analysis, and fabrication practices that are applicable to low-cost mechanical projects like sieving machines. Timoshenko's theory on materials [29] also supports design decisions related to frame rigidity and mesh deformation.

The use of tools such as **SOLIDWORKS Simulation** [4] has enabled designers to conduct finite element analysis (FEA) to determine stress concentration points, validate design loads, and optimize weight without compromising strength. Rajput [21] and Rao [26] also emphasize the importance of manufacturing process optimization in such dynamic systems.

On the standards front, IS: 2405-1980 [5] outlines the general requirements for industrial screens and sieves, while IS: 2062:2011 [27] specifies the properties of mild steel used in structural components.These standards ensure that the machine can withstand dynamic forces without failure.

Recent advances also include the use of **compact sewing machine motors** [23], which are lightweight, affordable, and equipped with built-in speed controllers. These motors are ideal for transferring controlled rotary motion in small mechanical systems. Websites like *Matmatch* [25] and *MakeItFrom.com* [30] provide valuable material data, aiding in the selection of suitable metals like AISI 1020 and ASTM A36 for frame and tray components.

The integration of dust control mechanisms, portability, and energy-efficient operation (e.g., solar-powered motors) has been discussed by sources such as OSHA [22] and *Construction World* [24], indicating a trend toward safer and more sustainable mechanised systems in field environments.

The literature reviewed thus establishes a solid foundation for the development of a **motorised sand sieving machine** that is not only efficient but also cost-effective, durable, and scalable for rural and urban construction use. Emphasis on proper material selection, motion mechanism design, and vibration control are consistent themes that contribute significantly to improved sieving performance.

3. DESIGN AND METHODOLOGY

3.1. DESIGN OF THE PROPOSED MACHINE

The motorised sand sieving machine is designed to achieve efficient filtration of sand with minimal human effort. The design integrates structural simplicity, affordability, and reliable operation using readily available components. The key design considerations include the sieving mechanism, power transmission, frame strength, and modularity.

3.1.1. Structural Design

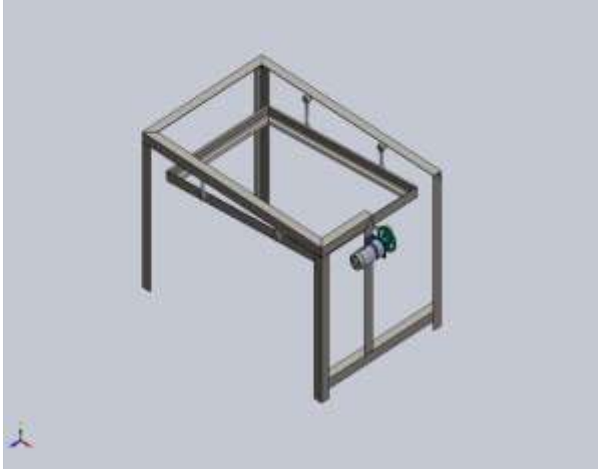

Fig 3 - 1 Machine design

Frame: The machine frame is constructed using **mild steel angle rods (IS 2062)** due to their high strength-to-weight ratio, weldability, and affordability.

Sieve Tray: A flat iron sheet tray is fabricated to hold the wooden sieve frame.The tray is designed to move back and forth via a crank mechanism.

Sieve Frame: Made from **hardwood or plywood**, this frame holds the **wire mesh** and is placed on top of the iron tray. It is removable, allowing for easy cleaning or mesh replacement.

Pitman Rod: A flat mild steel rod connects the crank to the sieve tray to transmit reciprocating motion.

3.1.2. *Power and Motion Mechanism*

Motor: An AC **motor (50–100 W)** with a speed controller is used due to its high RPM, compact design, and availability.

Crank Mechanism: A crank is mounted on the motor shaft with an eccentric hole to produce reciprocating motion when the motor rotates.

Connecting Rod: The rod links the crank to the sieve tray and transfers motion smoothly. All rotating parts are balanced to minimize vibration and noise.

3.2. METHODOLOGY

The project was executed using a systematic engineering approach to ensure functionality, safety, and cost-effectiveness. The methodology followed the steps below:

3.2.1. Problem Identification and Objective Setting

A need was identified for a simple, low-cost sieving solution to improve sand quality on construction sites. The objective was to develop a machine that reduces labor and increases sieving efficiency.

3.2.2. Conceptual Design and CAD Modeling

A preliminary sketch was converted into a **3D CAD model using SOLIDWORKS**. The model included:

- Frame geometry
- Crank mechanism
- Motor placement
- Sieve tray and mesh mount

3.2.3. Simulation and Structural Analysis

Using **SolidWorks Simulation**, static structural analysis was conducted to ensure the frame could withstand operating loads and vibrations. The stress and deformation analysis guided the material thickness and support placements.

3.2.4. Material Selection and Procurement

Based on design requirements:

Mild steel (IS 2062) was chosen for the frame and tray
Hardwood was used for the mesh frame

Mesh was selected based on desired sand granularity (2–5 mm)

A compact sewing machine motor with controller was procured from a local supplier

3.2.5. *Fabrication Process*

Cutting and Welding: Angle rods were cut to length and welded to form the rectangular frame.

Tray Assembly: Iron sheet was welded into a tray structure.

Sieve Frame: Wood was cut, joined, and mesh fixed using nails or screws.
Crank Mechanism: The crank was fabricated and fixed to the motor shaft with a hole offset for reciprocation.
Assembly: All components were aligned, drilled, and assembled using fasteners.

3.2.6. Painting and Finishing

After fabrication, the frame was cleaned, primed, and painted to prevent corrosion. The wooden parts were treated or varnished for durability.

3.2.7. *Testing and Performance Evaluation*

The machine was tested with river sand. Efficiency, vibration quality, and mesh performance were evaluated. Adjustments were made to motor speed and crank geometry to optimize performance.

FABRICATION

3.3. Fabrication Of Main Frame

Fig 4 - 1 Main frame

The main frame of the machine is constructed using mild steel angle rods. These are measured according to the design dimensions and cut using an angle grinder. The pieces are arranged into a rectangular structure and tack- welded to maintain alignment. Once the geometry is confirmed, full arc welding is done at all joints to ensure structural strength. The frame serves as the base on which the motor, sieve tray, and crank mechanism are mounted.

3.4. Fabrication Of Sieve Tray

The sieve tray is fabricated from iron sheets and angle rods, forming a rigid rectangularplatform. It is welded together to form a tray that can withstand constant vibration. The sieve tray is directly connected to the crank and connecting rod mechanism, which transfers rotary motion from the motor into reciprocating motion, enabling efficient sand separation.

3.5. Motor Selection

The machine uses a universal sewing machine motor, selected for its compact size, high RPM, and compatibility with lightweight mechanical setups.

Fig 4 - 2 Electric Motor

Al-Hind Sewing Machine Motor with Speed Controller

This motor is ideal for small mechanical systems due to its:

Power output of approximately 50–100W Built-in speed controller for adjustable vibration intensity

Compact form factor for easy mounting Compatibility with single-phase 220V AC supply

3.6. Crank And Connecting Rod Mechanism A crank is fixed onto the motor shaft using bolts or welding. A connecting rod is then attached between the crank and the sieve tray. The crank is designed with an offset to produce oscillatory motion, while the connecting rod is made from flat mild steel and drilled at both ends to enable pivoting. This linkage converts the motor's rotation into linear vibration of the sieve tray.

3.7. Wooden Frame And Mesh Sieve

A wooden frame is fabricated using hardwood or plywood, cut and assembled into a rectangular shape using nails and screws. A metal wire mesh (iron or galvanized) is stretched and securely fixed on top of this wooden frame. The wooden frame acts as a removable sieve holder, allowing mesh replacement if needed.

Fig 4 - 3 Sieve and wooden frame

3.8. ***Wooden Frame Onto The Sieve Tray*** The completed wooden frame with attached sieve is then placed on top of the iron sieve tray. It sits securely and vibrates along with the tray, ensuring effective sieving. Theweight and fit of the wooden frame keep it in place during operation. In some designs, clamps or rubber stoppers may be added to prevent unwanted movement.

Fig 4 - 4 Sieving machine

3.9. Drilling And Mechanical Assembly

All required holes for mounting the motor, crankshaft supports, and connecting rods are drilled using hand or bench drills. The components are then assembled using bolts, nuts, and washers. Bearings are installed wherever shafts rotate, ensuring smooth movement and reducing friction.

3.10. Painting And Finishing

After all metal fabrication is completed, the entire frame and tray are cleaned with sandpaper and degreased. A coat of anti- corrosive primer is applied, followed by a topcoat of enamel paint to protect against rust and wear. The wooden parts are also treated or varnished for durability.

Fig 4 - 5 Before Painting

Fig 4 - 6 After painting

4. RESULT

4.1. Performance Evaluation

The fabricated motorised sand sieving machine was tested under controlled conditions using mixed river sand containing fine, medium, and coarse particles. The machine's vibrating sieve tray, powered by a sewing machine motor, demonstrated smooth and continuous operation.Sieving Efficiency Comparison

Method	Time to Sieve 10kg Sand	Output (Fine Sand Collected)	Efficiency (%)	Labor
Manual Sieving	16 minutes	7.5 kg	75%	2 persons
Motorised Sieving	6 minutes	8.7 kg	87%	1 person

Table 5 - 1 Sieving data

4.2. *Observation*

The motorised system reduced sieving time by over 60% and increased output quality with less labor involvement.

4.3. Graph: Sieving Efficiency Over Time

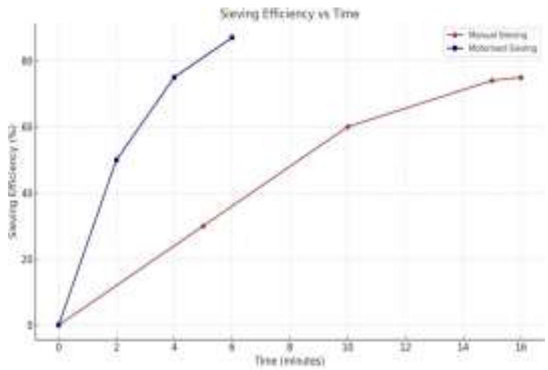

Fig 5 - 1 Sieving efficiency vs Time

4.4. Discussion

- The motorised sieving machine achieved better consistency in separating fine particles, especially when the input material was dry and granular.
- The adjustable speed controller on the motor allowed fine-tuning of vibration intensity based on mesh size and sand type.
- The use of a wooden sieve frame placed on an iron tray helped absorb vibration and reduced noise

during operation.

- Structural integrity was confirmed during continuous operation with no significant fatigue or joint failure observed.

4.5. Practical Advantages

- Time-saving: More sand processed in less time
- Labor-saving: Only one operator needed
- Uniform output: Better quality of sieved sand
- Compact and mobile: Can be easily transported and used on-site
- Low cost: Economical for small construction sites

4.6. Limitations Observed

- Slight vibration noise at higher motor speeds
- Less effective with damp or clay-rich sand

5. Mesh may clog with fine dust over prolonged use (requires cleaning)

FUTURE SCOPE

The motorised sand sieving machine developed in this project has demonstrated efficiency and practicality for small to medium-scale construction applications. However, there are several opportunities to enhance its design, functionality, and applicability in the future. The following points outline the possible directions for improvement and expansion:

Fig 6 - 1 Future Scope

5.1. Automation and Control Integration

The current model operates manually with a basic motor switch. Future versions can include automated controls such as timers, vibration speed controllers, and load sensors for intelligent operation.

Integration with a microcontroller (e.g., Arduino or Raspberry Pi) could enable programmable vibration cycles and automatic start/stop features based on load detection.

5.2. Multi-Layer Sieving System

- A multi-tier design with two or three sieve layers of varying mesh sizes can be developed to separate sand into fine, medium, and coarse grades in a single operation.
- This will increase functionality and make the machine more useful for specific industrial or construction requirements.

5.3. Portability and Modular Design

- The machine can be redesigned using lightweight materials like aluminum or structural composites to improve portability.
- A foldable or detachable frame can be introduced for easier transportation and storage.

5.4. Dust Control and Safety Features

- A dust collection or suppression system can be added to minimize airborne particles, especially in indoor or urban environments.
- Additional safety features like protective covers, emergency stop buttons, and vibration dampers can enhance operator safety.

5.5. Solar-Powered Operation

- The motor can be adapted to run on solar energy, especially for use in rural or off-grid construction sites where power supply may be inconsistent.

5.6. Industrial-Grade Upgrades

For higher-volume operations, the system can be scaled with a more powerful motor, reinforced frame, and continuous feed mechanism (like conveyors or hoppers).

This would make it suitable for use in brick manufacturing, foundries, and large-scale construction projects.

5.7. Commercialization Potential

With further refinement, the machine can be commercially manufactured and marketed as a low-cost, efficient alternative to imported or large-scale industrial sieving equipment.

There is scope for customization based on client requirements, making it a viable product for startups or small businesses in the construction sector.

6. CONCLUSION

The design and fabrication of the **motorised sand sieving machine** were successfully carried out with the aim of improving the efficiency and reliability of traditional sand sieving methods. The machine effectively converts rotary motion from a compact electric motor into a reciprocating motion of the sieve tray through a crank and connecting rod mechanism. The incorporation of a wooden sieve frame with replaceable mesh ensures flexibility and ease of maintenance.

Performance testing demonstrated that the motorised system significantly reduces sieving time and manual effort while maintaining consistent output quality. The structural design, made from mild steel and reinforced components, provided stability during continuous operation. The use of a speed-controlled sewing machine motor allowed adaptability to different sand types and working conditions.

The project fulfilled its objectives of creating a low-cost, portable, and user-friendly solution for small to medium-scale construction applications. With minor enhancements such as automated feeding, dust suppression, and multi-layer sieving, the system holds strong potential for commercialization and wider deployment in rural and urban construction environments.

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