

# *Semi-Automatic Wall Panel Cleaning Machine*

## *paper Design and Fabrication of a Cost-Effective Wall Panel Cleaning System*

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**Abstract**—Modern buildings frequently use glass and decorative wall panels which require regular cleaning to maintain aesthetics and durability. Manual cleaning at height is risky, time-consuming and labor intensive. This paper presents the design and development of a semi-automated wall panel cleaning machine intended to reduce human effort and improve safety. The proposed system uses a lightweight frame equipped with a rotating brush, water spray mechanism, and wiping system. DC motor drives the brush while a small pump supplies cleaning fluid through spray nozzles. The system moves vertically using a guided support arrangement allowing efficient cleaning of wall panels and facade surfaces. The design focuses on simplicity, affordability, and ease of maintenance compared to complex robotic cleaning systems. Experimental evaluation shows that the machine can effectively remove dust and dirt from panel surfaces while reducing cleaning time and operator risk

**Keywords**— Wall Panel Cleaning Machine, Semi-Automated Cleaning System, Facade Maintenance, Cable-Suspended Mechanism, Building Cleaning Technology, Mechanical Design, Safety Improvement, Cost-Effective Automation, Cleaning Mechanism, Vertical Surface Cleaning

### I. INTRODUCTION

In modern cities, buildings with large wall panels and glass surfaces require regular cleaning to maintain their appearance and hygiene. Traditional cleaning methods involve workers manually cleaning the walls using ladders or ropes. This method is time-consuming and unsafe, especially for tall buildings. To solve this problem, an automated wall panel cleaning machine has been developed. The machine is designed to move along the wall surface and clean it using rotating brushes and water spray. The main objective of this project is to reduce human effort and improve safety while cleaning building walls.[1],[2],[3].

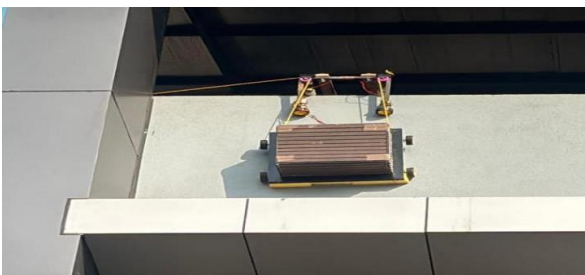


Figure 1. Wall Panel Cleaning Machine

### II. PROBLEM STATEMENT

Cleaning the exterior wall panels of buildings is an important maintenance activity. In traditional cleaning methods, workers use ladders, ropes, or scaffolding to clean the walls manually. Manual cleaning also requires more manpower and may not provide consistent cleaning results. In addition, accessing certain areas of the building can be difficult using traditional methods. Therefore, there is a need to develop a safe, efficient, and cost-effective solution for cleaning building wall panels. The proposed Wall Panel Cleaning Machine aims to reduce human effort and improve safety by using a mechanical cleaning system with rotating brushes, a pulley mechanism, and a water spray system.[1],[2],[3].



Figure 2. Manual Cleaning of Wall Panels in the college

### III. LITERATURE REVIEW

Many researchers have worked on automated wall cleaning and window cleaning robots. These machines are designed to reduce human effort and improve safety during building maintenance. Several wall climbing robots use suction cups, magnetic wheels, or rope systems to move along vertical surfaces. The cleaning operation is generally performed using rotating brushes or wipers along with water spraying mechanisms. Previous studies show that automated cleaning systems can significantly reduce the risk faced by workers while cleaning tall buildings. However, many existing systems are expensive and complex. The machine proposed in this project focuses on a simple and cost-effective design using basic mechanical components.[1],[2],[3]

### IV. STRUCTURE

The structure of the Wall Panel Cleaning Machine consists of a lightweight aluminum frame mounted on a trolley system. The trolley moves along a rope and pulley arrangement, allowing the machine to travel across the wall surface. Three DC 775 motors are used in the system. These motors help in rotating the cleaning brushes and driving the machine movement. A small water pump is used to spray water on the wall panels during cleaning. The entire system is powered by a 12-volt rechargeable battery. The lightweight design of the frame makes the machine easy to handle and reduces the load on the motors. The pulley mechanism allows smooth movement along the wall surface.[5],[6].

TABLE OF MAJOR COMPONENTS OF WALL PANEL CLEANING MACHINE

Sr. No.	Component Name	Specification	Function
1.	DC Motor	12-24V	Brush rotation
2.	Water Pump	12V Diaphragm Pump	Water spraying
3.	Spray Nozzles	Plastic/Brass	Water distribution
4.	Frame	Aluminum	Structure support
5.	Battery	Rechargeable	Power supply
6.	Squeegee	Power supply	Surface drying

Table 1. Major Components

### V. CAD 2D & 3D DIAGRAM OF DESIGN OF WALL PANEL CLEANING MACHINE

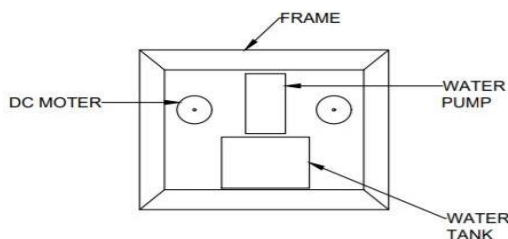


Figure 3. 2D Diagram of Front side of Cleaning Machine

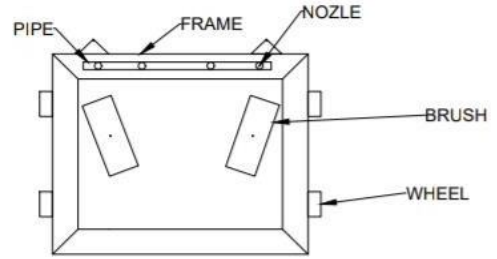


Figure 4. 2D Diagram of Back Side of Cleaning Machine

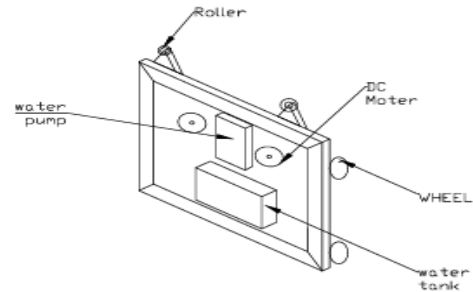


Figure 5. 3D Diagram of Front side of Cleaning Machine

### VI. WORKING PRINCIPLE

The machine operates using a combination of mechanical and electrical systems. The cleaning machine is suspended using a rope and pulley mechanism attached to the frame. When the system is powered, the DC motors rotate the cleaning brushes which scrub the wall surface. At the same time, the water pump sprays water to loosen dust and dirt from the panels. The machine moves vertically along the wall through the pulley system, allowing cleaning of a large surface area.

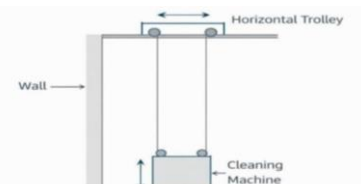


Figure 6. Working Mechanism of machine



Figure7. Water tank, water pump, DC 775 motor



Figure8. Rotating Brush, Spraying Nozzle, Guide Wheels and Rope Pulley



Figure 9. Horizontal Trolley



Figure 10. Winch Motor and Drum

The machine mainly consists of a DC motor, rotary cleaning brush, structural frame, winch motor for vertical movement, trolley wheels for horizontal movement, and a power supply system. All these components work together to achieve efficient cleaning of wall panels. As the machine is positioned against the wall, the DC motor activates the rotary cleaning brush, which scrubs the surface to remove contaminants. Simultaneously, the winch motor facilitates vertical movement, allowing the brush to cover the wall panel from top to bottom. The trolley wheels enable horizontal movement, ensuring uniform coverage of the entire wall surface. This coordinated motion ensures thorough cleaning without leaving any spots, making the process efficient and effective.[5],[6]

## VII. CALCULATION

- Total weight of machine (W) = 7 kg
- Gravity (g) = 9.81 m/s<sup>2</sup>
- Brush radius (r) = 0.05 m
- Cleaning force = 15 N
- Motor speed (N) = 1000 RPM
- Drum radius = 0.03 m
- Voltage (V) = 12V

### 6.1 Load Calculation

- Mass (m) = 7 kg
- $F = m \times g$
- $F = 7 \times 9.81$ ,  $F = 68.67 \text{ N} \approx 70 \text{ N}$  [4]
- Including factor of safety (FOS = 2):  $70 \times 2 = 140 \text{ N}$ .

## VIII. FUTURE SCOPE

The Wall Panel Cleaning Machine can be further improved by adding advanced technologies such as sensors and automation systems. Wireless control using a mobile application can also be introduced to operate the machine

remotely. The machine can also be modified to clean glass panels, solar panels, and building facades.

## ACKNOWLEDGMENT

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## Appendix A. An example appendix

The appendix section includes supplementary information related to the proposed wall panel cleaning system that supports the main content of the paper. This may include additional diagrams, component specifications, design details, or supporting information that helps in better understanding of the system without interrupting the flow of the main text. The appendix provides extra reference material for readers who want more technical insight into the proposed design.

*A.1. Component Details and Specifications. This section provides additional information about the major components used in the proposed wall panel cleaning machine. The system includes a DC motor for brush rotation, a water pump for spraying cleaning fluid, spray nozzles for uniform distribution, a lightweight frame for structural support, and a cable suspension mechanism for vertical movement. These components are selected based on cost-effectiveness, simplicity, and ease of maintenance to ensure practical implementation of the design.*

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