The Design and fabrication of Semi-Automatic Wall plastering machine

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Abstract: It is a SEMI-AUTOMATIC WALL PLASTERING MACHINE that can do wall plastering with the help of a few manual operations. The present study objective is to reduce the manual work as well as construction costs with the help of proper gear arrangement, chain sprocket, conveyor belt, etc with proper calculation and selecting suitable materials. Finally, achieved the desire work output from the machine which is wall preparation of wall suitable for plastering, spraying the water for the plastering, and proper wall plastering with good surface finishing. After getting success of this model, the continue working on machine and make a fully automatic wall plastering machine that will be able to do mortar mixing in the machine itself after putting the proper ratio of sand, cement, and water. Doing wall plastering by sensing and scanning the wall with the help of sensors and proper programming without any manual operation. Due to this, the fast process will be saving the cost and time which will be ultimately be responsible for the growth of the country.

Keywords – Wall plastering machine, Construction site, Mortar preparation

1. Introduction

The rise of the building trade coincides with the rise of modern science, which is unable to achieve the perfection of plastering in a short time with a manual process at a minimal cost. To achieve the highest performance, parameters such as accuracy, precision, quality, and cycle time must be optimized. This is possible either by skilled labor or by automating the system. In today's world, Need a fast construction with perfection in a short time and at the lowest cost. Due to the manual process for this purpose, the contractor needs highly skilled workers, the civil engineer needs a large amount of work to complete the construction on time, which makes the construction work more expensive [1]. The contractors need to find highly skilled engineers and workers which is more time taken work and the project is delayed which results the project getting out of the contractor's hands. The manual process is the time taken to process it takes a lot of time. Not every worker is a skilled worker on a construction site. There are many workers who have to get implemented due to a lack of workers This may lead to accidents on construction sites [2].

The construction sites not getting a good finishing in work that leads to embarrassment for contractors by which they will unable to take on further projects. Wall plaster or plastering refers to construction or decoration with plaster, such as a layer of plaster on an interior wall or plaster decorations on ceilings or walls [3].

In the background section have discussed about a lot of problems from which contractors from small or large scale are dealing in their every new projects. That are lack of skilled workers which may lead to delay to complete work in the notice period unskilled worker waste materials which may lead to wastage of money. But these problems can be solved by semi-automatic wall plastering which will brings a new innovation in the whole construction industry. This machine can do a lot of work in very less time which is not mainly possible for all skilled workers. This machine can wet the whole area where it have to do plastering after that, it will plaster the mortar along with smoothing the whole surface with the help of a finishing trowel which will easily smoothen the surface. The whole process will save a lot of time, leading to completing the project before the deadline. This will not waste mortar, which will complete the project in given budget. These things will lead the construction industries in a new position which leads fast construction much thing will construct in a few period of time. This all things empower Country and help to get new achievements.

The country growth is somehow dependent on the civil work and construction industry also. Mostly countries like India totally dependent on the manual wall plastering which are responsible for more cost of construction.

The types of surface finishing techniques are as follows :

a) Proper finishing, can get by using steel trowel.
b) Generally in rural area they are using rough wall finish for villages or coastal areas by using the sand and crushed stone, the size of sand lies between 10.50 mm to 6.5 mm which are very coarse.
c) Texture finish or different design are now becoming famous and surface finish can be obtained by many ways rendering with hacksaw blade or steel trowels.

But these instruments don't have suitable capability whatever required for proper surface finishing. Also these machines are not able to replaster the wall for the damaged plasters.

Mahesha and Sree Rajendra [1] in their article "Design and Fabrication of Automatic Wall Plastering Machine" This task entails pressing mortar to create a surface level as well as putting mortar to the wall. The model's development and testing went well. With this advancement, two significant drawbacks to the building industries a labour shortage and a quality construction process with less waste—were diminished. During the tests, it was discovered that the machine was more productive than labour in terms of the work's groove and that the standard attained was commendable. Arivazhagan et al. [2] in their article "Automatic Plastering Machine" By using a machine-driven groove machine, can be achieve a flat and consistent finish with adjustable thickness to suit each application. This can be especially useful for large-scale projects where manual application would be time-consuming and labor-intensive. Integrating a liquid crystal display and computer keyboard can also improve the usability and efficiency of the machine, allowing for easy adjustments and monitoring of the process. Overall, using an automatic plastering machine can be a cost-effective and time-saving solution for the construction industry, helping to keep growing with the ever-changing demands of the automation of buildings.

Elattar et al. [3] in their article "Automation in Construction" Because it enables very precise activities to be carried out while lowering risky situations, and enhancing safety and control, the use of robots in building operations is growing in popularity. The design, engineering, and maintenance of both present and future structures are among the many tasks that can be automated in the construction industry. Several research studies advocate the use of highly autonomous robotic systems in construction, and the idea of "Sense-and-Act" is becoming increasingly prevalent as more sophisticated robotic systems are created for use in this industry. To improve the caliber of services provided by contemporary intelligent buildings, efforts should be made to encourage specialists in building management to integrate AI and building automation. On an empty lot, fresh ideas for automation or robotization should be produced by combining new designs, new forms, and new building materials that adhere to city building codes.

Unfortunately, not all issues in building engineering can be totally solved by calculation and improvement alone. A greater understanding of the building engineering challenge may result from intelligent actions including generalization, analysis, and decision-making for many objectives. The necessity for ongoing research and development in the field of construction automation arises from the desire to increase the effectiveness and efficiency of construction activities while assuring safety and control.

Arunkumar et al. [4] in their article "Automatic Wall Plastering Machine" In this study, cleared the conception about that structure construction is a time-consuming sector because a lot of work is labor grounded there's a too important deficit of professed labor, increase in labor cost and technological advances are forcing rapid-fire change in the structure construction. erecting construction substantially consists of marketable structure and domestic structure, but in every sector trouncing work is a must. Introducing a new machine to automate the trouncing work which is a veritably important demand for the construction field. The machine consists of AC/DC motor, Gearbox, line rope, pulley, charger medium, companionways, etc. The present work developed a model of a wall publishing machine. Johan Forsberg et al. [5] in their article "Construction Robot for Autonomous Plastering of Walls and Ceilings". In this paper, they compared the surface finishing of the robot that had less than 50% accuracy because the machine had mechanical errors, control errors, and navigation errors. They have given a proper solution to rectify the problems through which the machine can get a good finishing compared to the manual process.

G. Pritschow et al. [6] Studied on the "On site Mobile Plastering Robot: A Practical Design Concept" This is the summary of a wall plastering robot which requires skilled labour to operate on the construction site. This journal explains the working and kinematic structure of a working robot. Dr. S. K. Rajesh Kanna et al. [7] in their article "Automatic Wall Plastering and Repairing Robot using Artificial Intelligence" Studied the Automatic Wall Plastering and Repairing Robot using Artificial Intelligence. By the help of the high torque motor the poppet will be moved. The mortar will be applied to the vertical walls by the robot to have self-adjusting capability.

3. Objective

Based on the research and findings got the automation gap in the plastering process. Ambition is to design and develop a semi-automatic wall plastering machine which will be low cost and reduce the construction cost.

1. To reduce the cost of construction.
2. To reduce the manual work on construction site.
3. To design and fabricate the components and subassemblies of semi-automatic wall plastering machine
4. To assemble the all components of wall plastering machine.
5. To test the semi-automatic wall plastering machine
6. To remodify the Semi-automatic wall plastering machine if required after testing.

4. Calculation

(a) Load on hopper
Width of plastering = 1 ft = 30.4cm = 0.304m
Height of plastering = 6ft = 132 CM = 1.82 102
Thickness of plastering = 1cm= 0.01 m
Ratio For mixing = 1:4
Mortar Density, ρ = 2400 kg/m²
Volume of plastering, V = plastering width x
Plastering thickness x plastering height
V = (0.304 x 0.01 X 1.82) m^3
Mass of the hopper = density x Volume of plastering
m = ρ * v
= 2410x0.5.53 28x10-3
m = 13.29 kg
The total weight on the hopper including
The cement mixture 12 kg
The maximum force acting on the chain is
F = W * G
= 12*9.81
= 117.72 N

(b) Gear Design
Motor used = 12 V, DC Motor
Motor Speed (N1) = 65 rpm
Chain sprocket diameter (D_1))
Another chain sprocket diameter (D_2) = 45mm
N1/N2=D2/D1
N2=N1×D1/D2

=65×45/45
=65 rpm
Assuming speed reduction gear box of
30:1

(c) Design of Column.
Material used- Cast iron
factor of safety for steady Loads (F.0.5)
Young's modulus =164 hpa
Moment of inertia of cross- section
Ixx = 20×20^3/12 - 16×16^3/12
=13333.333 - 5461.33
= 7872 mm^4
Iyy = db^3/12 - d1b1^3/12
=20x20^3/12 - 16×16^3/12
=13333.333 - 5461.33
=7872 mm^4

(d) Design of Chain and Sproket
Upper Sprocket teeth, $T_2 = 51$
lower Sprocket teeth, T1 = 51
Iyy = db^3/12 - d1b1^3/12
=20x20^3/12 - 16×16^3/12
=13333.333 - 5461.33
=7872 mm^4
Effective length, Le = 1981.2^2/2
= 990.6 mm
Cripping load (P): π^2 EI / le^2
P = A^2 X 210000 X 7872 / (990.6)^2
16. 653 KN
Safe Load = Cripping load(P) / f.05
= 16.653 / 4
= 4.1575KN/s
Chain Sprocket
Upper Sprocket teeth, $T_2 = 51$
lower Sprocket teeth, T1 = 51
from table,
Chain 08b – 1 (Assuming)
Pitch, P2 = 12.7 mm
Roller Diameter = 8.51 mm
Width of the roller, W = 7.75 mm
Breaking load, Wb = 3180 kg = 31.2 KN

$$d1 = Pcosec\ \frac{180}{T1}$$

$$d1 = 12.7\ cosec\ \frac{180}{51}$$

d1 = 216.74 mm
Pitch circle diameter
D2 = 216.74 mm = 0.216 m (No. of teeth for both sprocket is same)
Pitch line velocity, $V = \frac{\pi d1\ N1}{60} = \frac{\pi * 0.216 * 65}{60} = 0.734\ \frac{m}{s}$
Load on chain, $W = \frac{Rated\ power}{Pitch\ line\ Velocity} = \frac{0.210}{0.734} = 0.28616\ KN = 286.16\ N$
The maximum Distance between the both sprocket is 1600 mm
$\therefore x = 1600\ mm$

$$K = \frac{T1 + T2}{2} + \frac{2x}{P} + \left[\frac{T2 - T1}{2\pi}\right]^2 * \frac{P}{x}$$

$$K = \left(\frac{51+51}{2}\right) + \frac{2*1600}{12.7} = 302.96$$

Length of the chain, L = K * P = 302.96 * 12.7 = 3847.7 mm

5. CAD Model of Semi-Automatic wall plastering machine

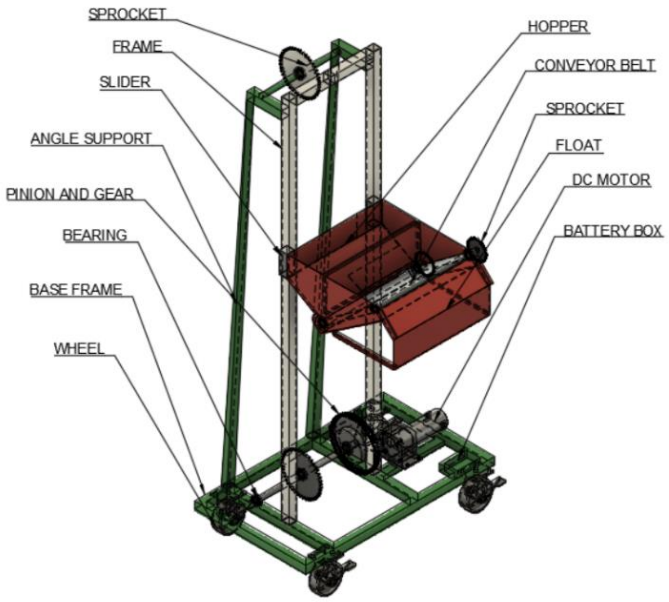

Fig. 1. CAD MODEL OF SEMI-AUTOMATIC WALL PLASTERING MACHINE

6. Fabrication and working of Semi-Automatic wall plastering machine

All the designed components and materials such as, steel sheet, hollow bar, wheels, motors, chain sprockets, etc. were procured separately. Sub-assemblies was fabricated separately and finally all sub-assemblies was assembled as per CAD model. The motor was controlled by the toggle switch.

At first, the "semi-automatic wall plastering machine" should reach close to the wall. Switch on the main switch and the machine will start the operation of grooming and water will be through the sprayer nozzle simultaneously while going from the bottom to the upward direction. The sprayed water will provide cooling as well as remove all the dust and it will make a wet surface of the wall. When the machine will reach the upper portion of the supporting column the wall will get the regular plain and smooth surface simultaneously machine will be reversed with the help of sensors. In the next step, the machine will come from upper to bottom by changing the tool automatically it will make the groove inside the wall. That groove will help to stick the mortar while the plastering process. In the next step, the machine should be switched off and the hopper will be filled with proper mixed wet mortar and again it will start the process. During this process the grooming cutter will come backward and the plastering float should reach the correct position in front of the wall after that the machine should be switched on then the conveyor belt will start rotating due to the rotating motion in the conveyor mortar will move forward to the wall and due to the forward pressure mortar will stick on the wall simultaneously the machine will reach the upper portion from the bottom slowly by using speed reducing mechanism. Resulting in the help of plastering float and upward movement of the machine. The wall will get little smoothness on its surface when it reaches the final upper position the conveyor belt will stop rotating by some sensors and the plastering float will change its position and the machine will come downward. During this process, the wall will get a super smooth surface. And again and again, the process will be followed.

7. Result and Discussion

After fabrication and testing of the Semi-Automatic wall plastering machine have compared the process of the wall plastering from the manual operation and got tmachine is capable to do the operation more efficiently from the manual operation and it is cost efficient because of no wastage of mortar, less requirement of skilled labour, can be operated by two operator it takes less time to plastering the wall.

Plastering the wall with a suitable surface finish is part of the current task. The model's development and testing went well. The majority of construction-facing cases may decrease as a result of this evolution. They claim that there is a shortage of manpower and that construction is of low quality. By testing, it has been established that the machine in the field of wall plastering is superior to labour and also produces quality that is almost identical to manpower.

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