Design and Manufacturing of Prototype of Automatic Wall Rendering Machine

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A thesis submitted in partial fulfillment of the requirements for the degree of Bachelors of Engineering in Mechanical Engineering

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National University of Sciences & Technology

FINAL YEAR PROJECT REPORT

We hereby recommend that the dissertation prepared under our supervision by: {Adnan Anwar BaigNUST201200454BSMME11112F, Muazam Shahzad (NUST 201200425BSMME11112F), Salman Younis (NUST 201200974BSMME11112F)} Titled: {Design and Manufacturing of Prototype of Automatic Wall Rendering Machine} be accepted in partial fulfillment of the requirements for the award of Bachelors of Engineering in Mechanical Engineering degree with (grade)

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Copyright Statement

Dedicated to our parents, friends, those who helped us in making this project possible and to ME-04

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Abstract

This report follows the research and development of a Final Year Project. The project involved in the Designing and Manufacturing of the Working Prototype of Automatic Wall Rendering Machine.

Rendering is known as ornamentation of wall done by masons. This ornamentation of walls needs more efforts of humans and also consumes more time in manual process. This project is an intention to implement an innovative process with the development of a prototype of “Automatic Wall Rendering Machine”. Automation is one of the significant and evolving disciplines among all technologies. Our aim for this innovative idea is to render the walls automatically. This idea aims in reducing the effort of mason.

The report begins by introducing the project in general terms, and moves on to discuss the designing process of each part of the machine in detail, their manufacturing processes, the problems encountered in these processes, their solutions and working of the Prototype.

Lastly, the report discusses the possibilities of future work that can be applied to this project.

Keywords; Automatic Wall Rendering, Wall Plastering, Automation of Construction.

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Chapter 1 Introduction

1.1 Motivation and Aims of the Project

Every course that is taught and every project that is carried out in Engineering Degree have their own significances and uses in practical life and in industry. One of these Projects is the Final Year Project. This Project is aimed to establish sound understanding of the courses studied during the four years of engineering and their application in solving the engineering problems.

Building and Construction is one of the major industries around the world. In this fast moving life construction industry is also growing rapidly. But the labors in the construction industry are not sufficient. This insufficient labor in the construction industry is because of the difficulty of the work. In construction industry, during the work in tall buildings there is riskier situation. Another reasons for the insufficient labor is because of the improvement in education level of public which cause the people to think that these types of work is not as prestigious as other jobs.

As the construction industry is labor-intensive and conducted in dangerous conditions. Therefore, the importance of construction robotics has been realized and is growing rapidly. Applications and activities of robotics and automation in construction industry started in the early 90s aiming to optimize equipment operations, improve worker safety and furthermore, ensure quality environment for building occupant. After this, the advances in the robotics and automation in the construction industry has grown rapidly.

As Rendering is necessary for the buildings as it gives strength and aesthetics to the walls. Despite the advances in the robotics and its wide spreading applications, rendering or plastering is still considered to be a difficult process to be carried out automatically. So, this problem in our construction industry was identified and analyzed. General way of rendering the wall is that a mason throws the plaster material i.e. plaster or stucco on the wall manually to make it stick to the wall and then uses a planer to make it smooth. This process is very slow and time consuming and tiresome for the mason. So, this project was done with the aim to solve this problem.

1.2 Objectives

- To Design and Manufacture Working Prototype of Automatic Wall Rendering Machine
  - Which should be easily maneuverable and able to reach every corner of construction site
  - Easy to use so that a mason can be easily trained to use it
  - Should use simple operating mechanisms which can be easily troubleshot and repaired
- Equipped with smart system to vary the thickness of plaster as required

Chapter 2 Literature Review

2.1 Introduction to Rendering

Rendering is the process of applying the mortar or plaster on to the walls. If this process is applied on inside walls this is called as **plastering** and if this process is applied on outside walls this is called **rendering**. There is just a small difference in these two processes, i.e., material composition. Materials used in these two activities are similar and include cement, lime, gypsum, sand and other mixing materials. In Rendering, richer mixture containing more cement content is used because it must be water resistant and must not develop any cracks when exposed to rain and heat for long durations. But still these words are often used interchangeably for the same process.

2.1.1 Purpose of Rendering

Fireproofing of metal structural framing is today a large market for the plastering industry and provides a life/safety benefit to the public. Plaster is also an insulating agent for heat transfer control in boats, refineries and many other commercial usages.

Plaster also provides some protection against seismic waves (earth quakes) according to a study done by university of California and British Colombia University. The study concluded that structures with plaster coating on top of them had superior strength in case of earth quake. One major purpose of plastering is its aesthetic appeal.

2.1.2 What is Plaster?

Plaster also known as mortar or stucco, is a sticky material made with combination of materials like sand, cement, lime and aggregates, which when mixed with a suitable amount of water forms a plastic mass. When this plastic mass is applied to a surface of wall, it adheres to the surface and sets into a rigid state. This rigid mass then gives strength and aesthetics to the surface.

2.1.2.1 Composition of Plaster:

Plaster is composed of binder, an aggregate and water. There are three types of material that are used as binder in plaster:

- Gypsum
- Lime
- Portland Cement

2.2 The Traditional Process of Rendering

Rendering or Plastering is usually a manual labor process. Manual process way of plastering is done by the mason as he throws the plaster material on the wall to get it stuck to it and then he plains the plaster by using a hand tool. Typical hand tools are used for this purpose are:

- Trowel
- Bucket tool
- Plasterers hawk
- Floats

Fig 2.1: Hand Tools of Rendering

Rendering process extends over a period of days. First the structure to be covered is prepared. In case of brick walls, it is suggested that joints should be racked at least **15mm** and **20mm** for stone work. In case of concrete structure, hacking at close intervals with hammer and chisel is done. This is done to create maximum surface area for plaster to bond with and stick in between. The surface should also be clean and free of any dust or cement particles as they can interfere in bonding process.

a

b

Fig 2.2: a. racking of brick wall, b. hacking of concrete structure

2.2.1 Material preparation

Plaster is a composite of three materials. A binder (like Cement), an aggregate (like sand) and water. The finer the aggregate is, the finer the finished surface looks. The suggested mixture ratio of cement to sand for plastering is 1:6 for ordinary purpose. The material should be prepared in such amount that it can be used within 30 minutes of preparation otherwise it will start hardening before its application.

Situation	Mix	Thickness
Ordinary buildings	1:6	13 mm
Important buildings	1:4	13 mm
Drain, skirting, dados, etc.	1:3	13 mm for drains, 19 mm for skirting and dados
Septic tanks, reservoirs etc.	1:2	19 mm

Table 2.1: Plaster Composition

2.2.2 Steps of Rendering

Usually plastering is done in three teps or coats which are:

Scratch coat: The thickness of this coat should approximately 10 mm to 12.5 mm and must be laid over the full length of the wall or the natural breaking points like doors and windows.

Base coat: The surface of scratch coat should be dampened evenly before base coat is applied. This coat is about 10 mm thick depending upon the overall thickness and then roughened with a wooden float to provide bond for the finishing coat. The second coat must be damp cured for at least seven days and then allowed to become dry.

Finishing coat: Before this coat is applied, the base coat is dampened evenly. Joints should be avoided and the finishing coat should be applied in one operation with thickness not exceeding 6 mm.

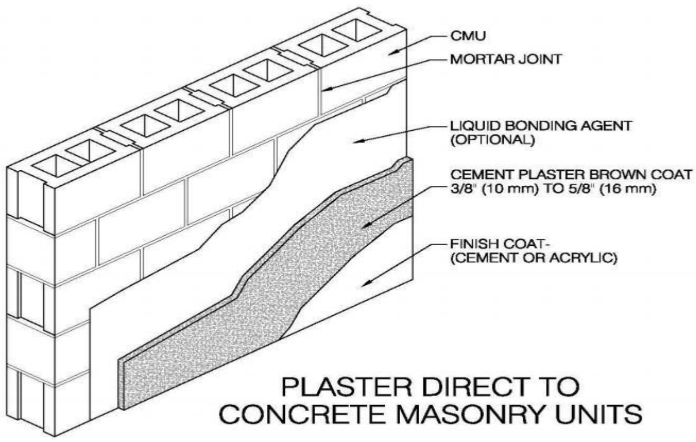


Fig 2.3: Coats of Plaster

2.2.3 Curing process

24 hours after final coat is applied, curing process starts. It continues for at least 7 days during which it is kept wet with water.

2.3 Automation or Robotics in construction

Robotics has been revolutionizing our manufacturing and industrial processes for last half century. We have industrial units now days where it is uncommon to see a man on the assembly line, but robots have replaced all manual labor tasks. Construction industry sometimes makes up to 10% of GNP of some developed nations but it still has not seen the speed and efficiency of robotics. Some experts think that the nature of construction is not suited for automation and robotics. Robots are good at systematic and repetitive tasks while providing the same quality of work in every repetition. Construction is considered to be a prototype industry. Every new project is unique and different which is totally opposite to what robots are good at. In recent years, we have been able to incorporate semi- automatic to fully automatic systems doing some basic level tasks like fitting floor tiles or filling concrete. This was only made possible by breaking down those complex tasks to small repetitive tasks that involve lots of motion. Below is discussed a semi-automatic solution being used for rendering process.

2.4 Automated Process of Rendering

Automatic Wall Plastering Machines are used in some countries like China and India work on approximately the same method. The main components of machine assembly include;

- Machine with a hopper (hopper holds the material temporarily)
- Vertical Rail
- Vertical Head or Stopper

Machine is placed near the wall at a distance equal to width of the plastering layer needed. Vertical Rail is mounted to give a pathway to the machine to plaster the wall in vertical direction. Stopper is fixed at the top of the Rail with the ceiling. The function of stopper is to stop the machine as it reaches the top of the wall. Material is poured manually by laborer into the machine Hopper. Inside the hopper, there is a gear pump which pumps the material as an output to the wall through a slit. Material which came out is captured by the metal plate and it is stuck to the wall. Then metal plate punches it to the wall and gives it a smooth finish. In one go, width of the plastered wall is the same as the width of the machine whereas maximum height plastered depends on the height of the Vertical Rails. When machine moves upwards, it sticks the material on the wall and when it comes back to the base; it smoothens the plaster. Then it is manually displaced to plaster the other part of the wall.

a

Required ceiling support

b

Plaster head

c

Automatic wall rendering process

Fig. 2.4 Rendering

Advantages

- Can plaster $500m^2$ per day according to company's claim.
- Small in size, can be moved across doorways easily.
- Weighs around ~ 100 kg.
- Runs on AC power.
- Covers 500mm – 800mm width at a time.

Disadvantages

- Requires large setup time before beginning of operation.
- Planer is fixed and cannot change the layer thickness on the go.
- Can only be used under a roof because frame works under compression and needs a support at top.
- Can only be used for indoor work until the frame is redesigned.
- Can only plaster straight surfaces and cannot work on curved surfaces.

Chapter 3 Methodology

This project went through different stages to become a final product. Starting as a concept design and then converted into CAD model and FEM simulations to check whether the design is strong enough and reliable to be fabricated or not. After designing and modeling, drawings for the shop floor were made to begin its fabrication.

3.1 Designing

3.1.1 Concept Design

The first step in coming up with a concept design was to look at already existing solutions. We went through hours of videos showing such machines in operation. Also we had to add some innovation to existing solution so we started looking for a different lifting system that can be used which does not have physical limitations like those mentioned before. For lifting system, we short listed 3 types of system, *scissor* type lift, *cascade* lift and *continuous* type lift.

Scissor

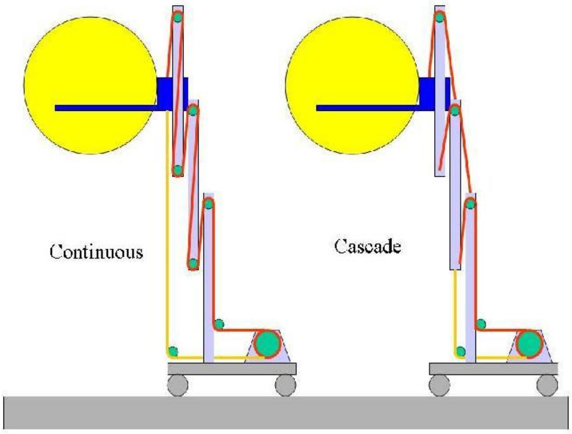


Fig 3.1 Lifting Systems

For lifting system, using our engineering knowledge, the best solution seemed to be the cascade type lift as it is easy to manufacture and control and also requires less working space then the scissor type.

Machine on the whole was divided into two main parts:

- Machine Head
- Lifting System

Designing was started by fixing some parameters like

- Machine rendering area of wall to be 6ft by 1.5ft
- Time taken to render the area is 100-110 seconds.
- Continuous Lifting Mechanism to be used for lifting the Machine Head.

3.1.1.1 Machine Head

It is the component which stores the plaster material for one length of the wall and pastes it onto the wall.

Components of Machine Head:

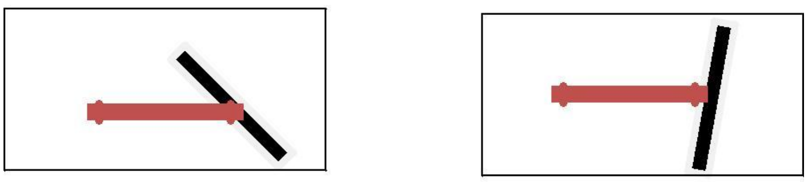
Hopper/Head frame

To store the plaster material for one length of the wall

Planer

A metal plate which evenly smudges the plaster to wall and plains it. Planer has two types of movements; one in the horizontal direction to vary the thickness of plaster layer, and other is the rotation about its center axis to 45°-135°.

As the Head moves upwards Plainer will be at 45° to stick the plaster on the wall and on moving downwards Plainer is at 110-115° to plain the plaster and give clean finish.



Initial angle of plate (45^{o}) at start of operation

Plate angle during planer operation ($110\text{-}115^{o}$)

Fig 3.2 Plate Angles

Small Conveyer Belt

To transfer the material in hopper to the planer

3 motors

One for conveyer belt movement, other two for movement of planer

3.1.1.1.1 Calculations of Machine Head:

List of set parameters

- Rendering thickness = 1.25cm (normally used plaster layer thickness)
- Rendering speed = 4.5cm/s
- Length and height of one layer (1.5 x 6 ft)
- Cross sectional Area = $45cm^2$(render layer cross sectional area)
- Total weight = material + head + moving column
  80kg = 25kg + 20kg + 35kg
- Total displacement of machine = 180cm (6ft)
- Total time to reach 6ft = 40s

3.1.1.1.2 Conveyer Belt speed

- Volume Flow rate = Area x speed = 253.125 cm^3/sec
- Required flow rate = $253.125cm^3$/sec
- Area = 2.54 x16 x 2.54 = 103.225 cm^2
- Conveyer belt speed = 253.125/103.225 = 2.45cm/s

3.1.1.2 Lifting Mechanism

Cascade Lifting System is used in the machine. This lifts the Machine Head to the required height i.e. 6ft in this case. Pulleys are used in this mechanism. Cascade is divided into 2 columns, one movable and other fixed to machine base. Moving column can be lifted up to 3 ft. while attached to fixed column; whole assembly can lift the mounted plaster head to 6ft.

3.1.1.2.1 Lifting Mec hanism Calculations

- Velocity = .045m/s (4.5cm/s)
- Ideal lifting Force needed = 780 N
- Power = For ce x Velocity
- Lifting Outp ut Power needed = 780 x .045 = 36W
- Efficiency of Motors = 75%
- (Slippage + Bearing) friction = 10% x Lifting power = ap prox. 4W
- Total Output Power needed= Lifting Power + Friction = 36W + 4W = **40W**
- **Selected Motor Specification = 180W single phase AC motor**

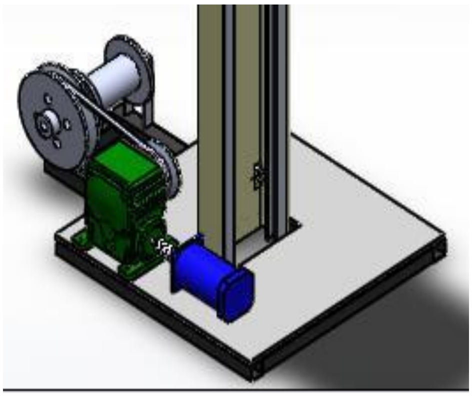


Fig.3.3 Motor &Gearbox

Power transmission

In order to op erate the lifting system, An Ac single phase motor with power rating of 180W was used. Along with that, a **60:1** worm typeself-locking gear box was used to get the desired rpms at the output. For lifting the m etal beams, pulleys and steel rope were u sed. Steel rope was wrapped around a win ch to generate the lifting force.

Calculations

Known parameters

- Motor shaft power = 180x0.75 = 135W
- Worm type gear box ratio = 60:1
- Gear box efficiency = approx. 45%
- V-belt for power transmission **B-33**

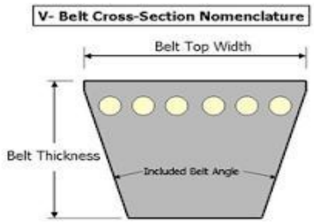
Force and torque at winch

- Winch diameter = 3.86 in (9.8 cm)
- Desired rpm of winch = 8.8 rpm
- Tension in steel rope = 795 N
- Torque requirement for winch = 39 Nm

B-33 type V belt.

- Internal circumference of belt = 33 in
- Outer circumference of belt = 33 + 1.8 = 34.8 in
- Belt speed V = ____ = _______= 13.85 ft/min

___ 2



- Centrifugal force $F_c = K_c$ ( ) = 1.85E-04

where v is speed in ft/min and K_C is 0.965 for B-type belts

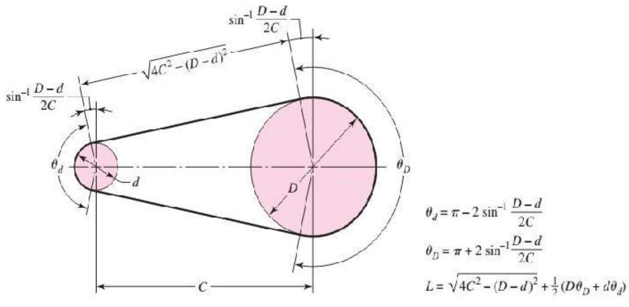
Wrap angle θd of driver pulley = 2.35 rad

Nominal power transfer H_{nom} = 60.75 W = 0.08147 hp

$H_d = H_{nom}$ X K_s X nd ***Where nd is service factor***

K_s = 1.0 and nd = 1.2 ***from bandousa catalogue***

H_d = 0.097 hp



(a)

$$\Delta F = \frac{63\,025 H_d/N_b}{n(d/2)}$$

Where **Nb** is num of belts and **n** is **rpm**

ΔF = 232.71 lbf

$$F_1 = F_c + \frac{\Delta F \exp(f\phi)}{\exp(f\phi) - 1}$$

Where = 0.4 for 38^{o} sheave angle and wrap angle is 2.35 rad

F_1 = 321.89 lbf

$F_2 = F_1 -$ F

F_2 = 148.18 lbf

F_i Initial Tension

F_i =

F_i =235.53 lbf

3.1.2 CAD Modeling

All CAD models, simuulations and drawings were made in Solid Woorks 2013.

3.1.2.1 Lifting Mechanism CAD Modeling

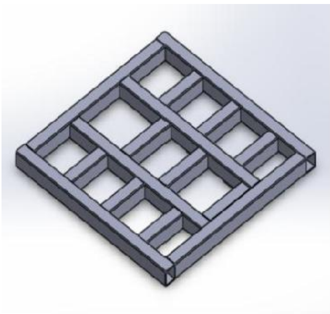


Fig 3.4: Base Frame

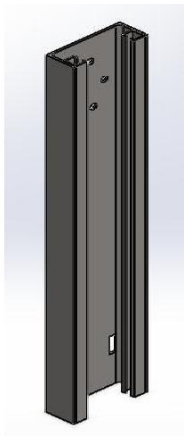


Fig 3.5

8-inch “C” Channel (fixed to base Frame)

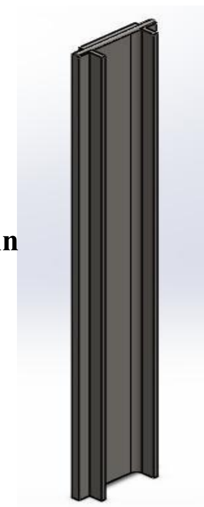
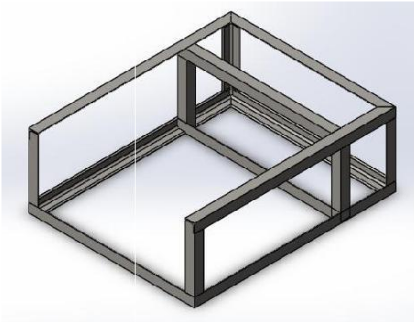
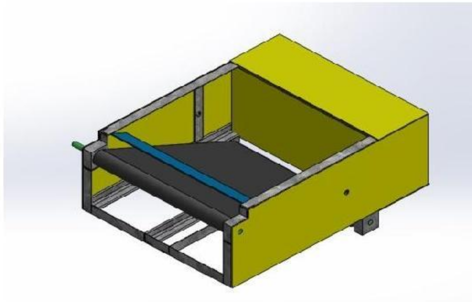


Fig 3.6: 4-inch movabble column

3.1.2.2Machine H ead CAD Models





a **b**

Fig 3.7: a: Head Frame, b: Head assembly

3.1.2.3 CAD Drawing s

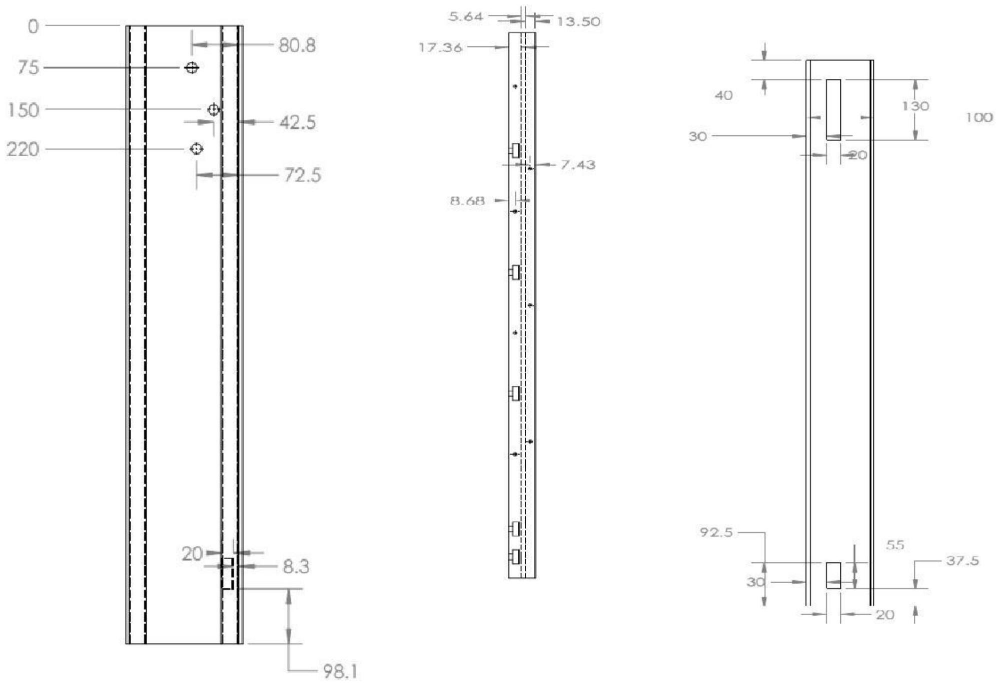
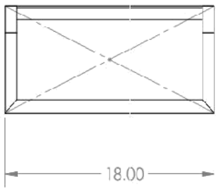
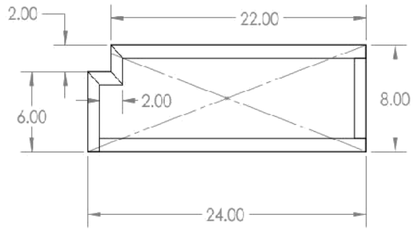
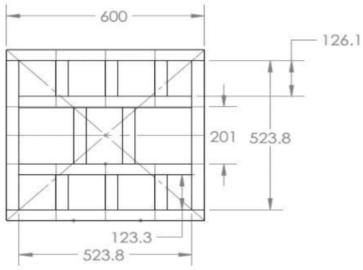


Fig. 3.8 Fixed & Lifting Columns



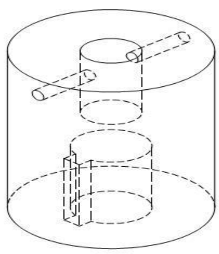


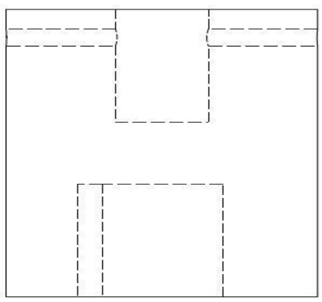
a b



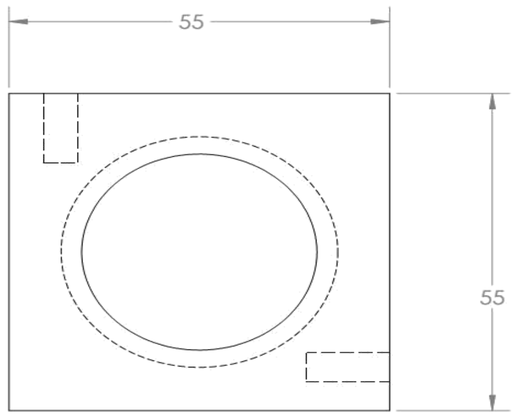
c

Fig.3.9 a: Head, b: Lifting Plate, c: Base Frame





a



b

Fig. 3.10 a: motor coupling, b: bearing housing

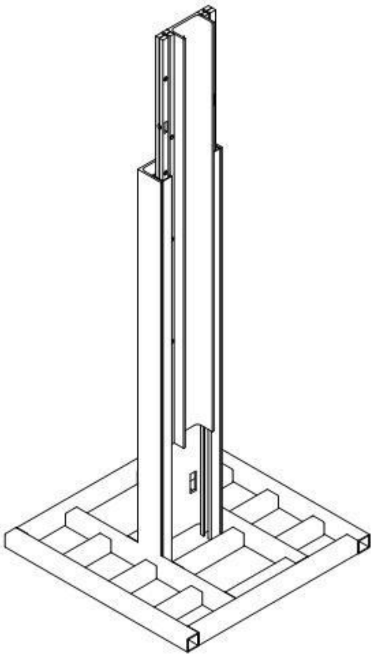


Fig. 3.11: Base Frame with moving channel

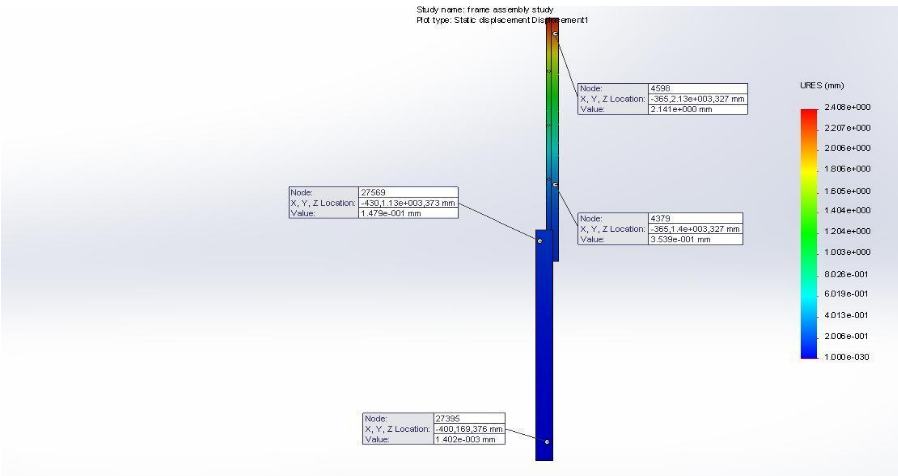
3.2 Simulations

Static mechanical finite element analysis was done for the lifting mechanism. For this analysis, moving beam was set stationary at its maximum position and a torque of 206 Nm of torque due to weight of head and 687 N of downward force at the top of beam were applied. Material properties for this simulation were that of AISI 1020 steel.

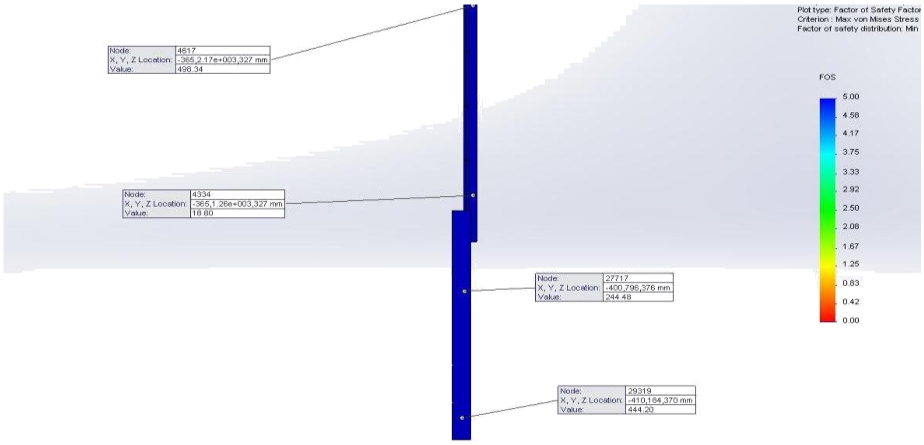
AISI 1020 STEEL	metric
Density	7900
poison ratio	0.29
Young modulus	2E+11

Table 3.1: Material Properties of AISI 1020 Steel

3.2.1 Simulation results

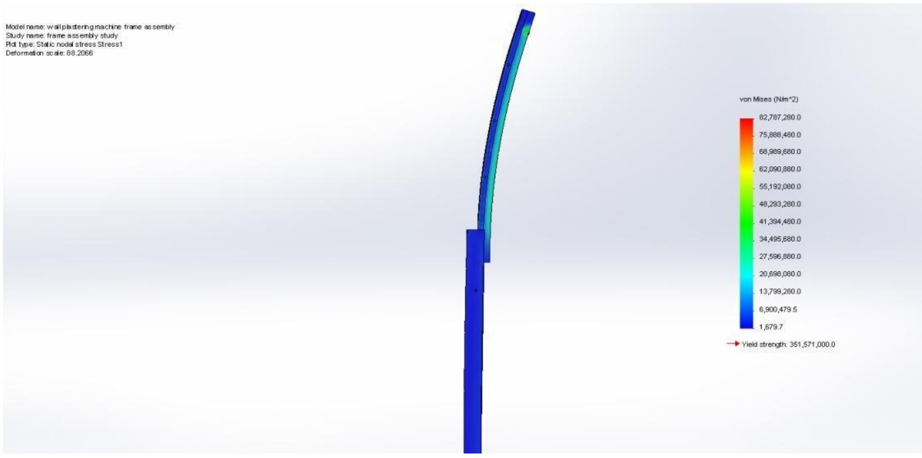


Maximum displacement in the upper beam is 2.4 mm



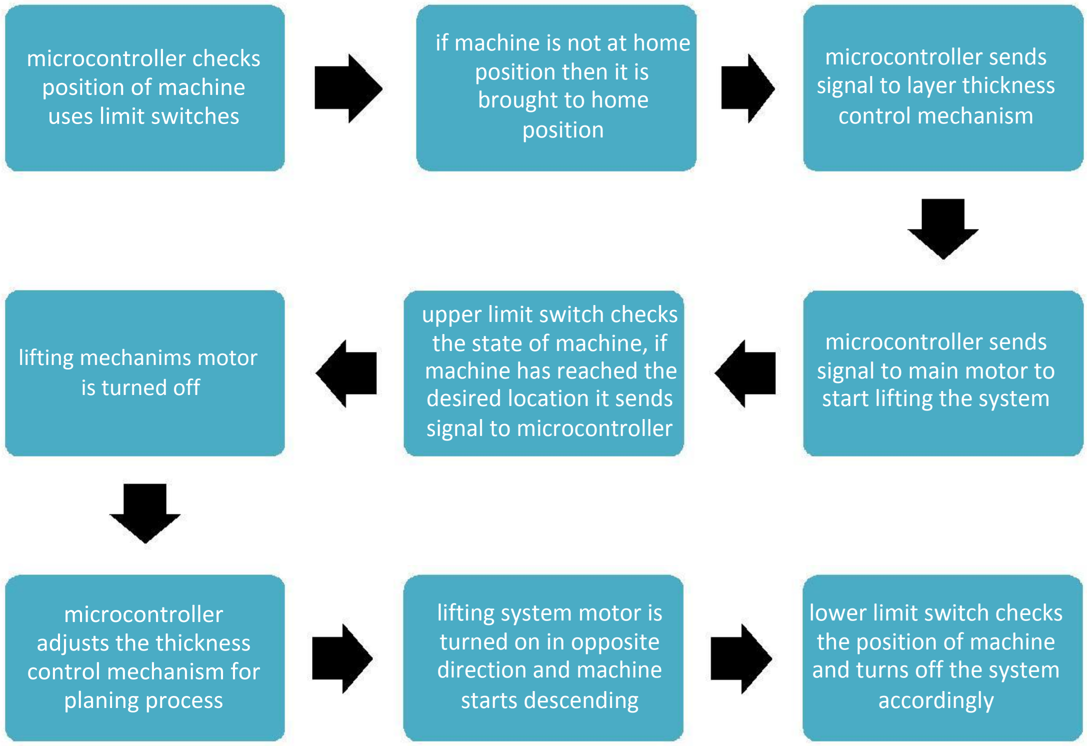
Results of factor of safety for upper beam.

At the most critical i.e at the bottom moving beam, FOS value is 18. This value is based on comparison of von mises stress



3.3 Automation and Control

This machine uses advanced electronics for control. It uses an Arduino microcontroller and a number of sensors for its operating. Along with that, it uses in total 4 electric motors to operate in the desired way. A layout of its operation is shown below



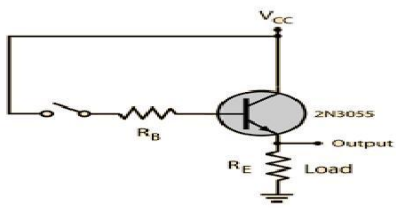
3.3.2 Electronic components used for automation

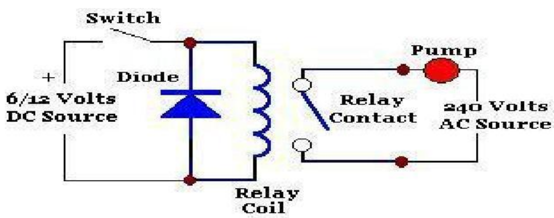
a. Limit switch

Limit switches are devices used to sense position of a body or a mechanism in an assembly. Usually these switches give electrical signal at the output. They work on several different principles like infrared light, ultrasound waves, magnetic induction and mechanical switches. For this project, mechanical limit switches were used to sense the position of machine at the two extremes of height.

b. Relay Switch

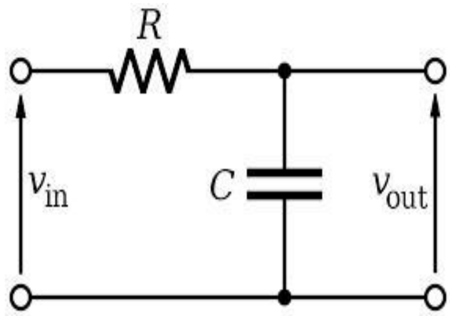
Relay is an electromechanical device used to control high power using low power inputs. A relay operates in such a way that when a coil present inside a relay





switch is excited, it toggles a switch. This functionality can be used to control high power devices like motors using small currents usually in the range of 250-500 mA. For this project, 2 relay switches were used. One for changes the direction of AC motor and other one two change the power status of motor. These relays were being controlled by microcontroller using transistor switches. Also a flywheel diode protection was also installed in the circuit to protect the microcontroller from back emf generated in relay coils.

c. Low Pass Filter Circuit



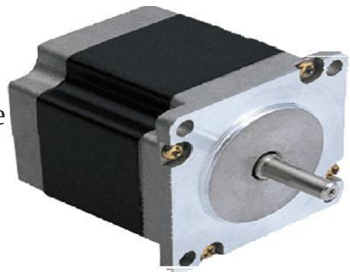
Another component used in this circuit was low pass RC circuit. RC circuits are used in signal processing circuits. According to their type, they allow a certain range of signal frequency to pass through and stop the rest. A low pass circuit only allows smaller frequency signals to pass through and stop high frequency signals as they can create unnecessary noise and disturb the normal functioning of microcontroller. Two low pass filters were used, each with a limit switch to filter out correct signal from noise generated due to bouncing in mechanical limit switch.

d. Stepper motors

A stepper motor is a brushless, synchronous electric motor that converts digital pulses into mechanical shaft rotations. Each rotation of a stepper motor is divided into a set number of steps, sometimes as many as 200 steps. The stepper motor must be sent a separate pulse for each step. The stepper motor can only receive one pulse and take one step at a time and each step must be the same length. Since each pulse results in the motor rotating a precise angle — typically 1.8 degrees — position of stepper motor can be controlled precisely without any feedback mechanism.

As the digital pulses from the controller increase in frequency, the stepping movement converts into a continuous rotation with the velocity of the rotation directly proportional to the frequency of the control pulses. Stepper motors are widely used because of their low cost, high reliability, and high torque at low speeds. Their rugged construction enables them to be used in a wide environmental range.

In this machine two stepper motors were used being separately controlled by the microcontroller. L298 motor controller was used to operate the motors. One of the motors controlled translation motion of planer plate and the other one was used to generate rotary motion of plate.



3.4 Manufacturing

Manufacturing is the term used for bringing ideas into life. It is the stage which converts engineering drawing into a tangible product. Manufacturing is very broad field and involves making of a small pin to manufacturing of large cargo ships. The most time consumed in a product development process is in manufacturing. When things start coming into shape from engineering drawings to physical objects, lots of difficulties and problems start appearing. Our prototype`s manufacturing started in late December 2015. The first stage of manufacturing was procurement of material. We made sure everything we had designed was available in local market. We first did a market survey to look for material availability in local market. Material procurement happened throughout the span of our project. We used the CITY SADDAR MARKET in Rawalpindi to fulfill all of our raw material requirements.

Manufacturing of most part of our prototype was done in the in house manufacturing facility available at SMME. Manufacturing resource center staff helped us a lot throughout the process. Their expertise and experience played a key role in completion of this project in time.

3.4.1 Machining

Machining is the process of material removal from a body. In mechanical engineering terms, machining is usually removal of excess metal from a body to achieve required geometry. Raw material available in the market comes in standard shapes and sizes and hence has to be machined to make parts and product. In our project, hot rolled and cold rolled steel was mostly used. Steel is a little harder than aluminum and requires larger cutting and holding forces. For manufacturing of our prototype, two most common machining processes were used.

a. Lathe

According to Wikipedia, “A **lathe** is a machine tool that rotates the work piece on its axis to perform various operations such as cutting, sanding, knurling, drilling, or deformation, facing, turning, with tools that are applied to the work piece to create an object with symmetry about an axis of rotation”. Wood and metals are most commonly used materials. In our project, several key components for prototype were machined using lathe. These parts are as below

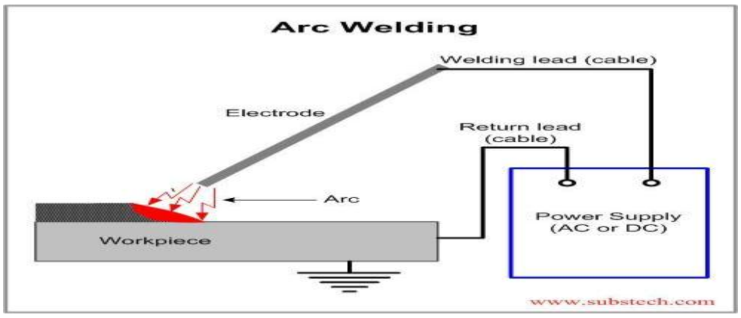
- Conveyer belt rollers
- Bearing housing
- Winch side support
- Winch drum
- Motor shaft couplings
- Pulleys
- Pulley support pins
- Shafts

b. Milling

Milling is another common machining process used for material removal. Milling and lathe are different from one another in that in milling process, cutting tool is rotating while work piece is fixed and in lathe it is vice versa i.e work piece rotates around an axis and cutting tool is fixed. Unlike lathe, milling can be used for any kind of symmetric or asymmetric geometry. Traditional milling machines were manually operated but newer machines are totally automatic and computer controlled ensuring work safety and higher output. For the purpose of our project, we used a 3 axis milling machine available at MRC SMME. Milling was mostly used for machining components of lifting mechanism. Hot rolled steel bars were machined to be used as side arms for slider mechanism in lifting system. Different types of cutting tools were used for machining this part that include end mill cutters, slitting saw and drill bits.

c. Welding

Welding is the most commonly used process to join two or more parts permanently. Welding usually restricts all degrees of freedom between the welded bodies. There are several different types of welding process but for this project Arc welding was used. Arc welding is considered a fusion welding process where high amounts of localized heat is produced using an electric arc that melts the surrounding metal and a filler material is added which seeps into the molten metal and creating a permanent joint.



In our project, most of the sub-assemblies were formed using arc welding. A list of parts where welding was used is shown below

- Plaster head frame
- Lifting mechanism assembly
- Winch assembly
- Base frame
- Lifting assembly mounting on base frame

Chapter 4 Conclusion

Construction is one of first talents mankind learnt. From its advent to this day, construction has not seen a lot of advancements in terms of processes involved. Much of construction is still done by manual labor. Robotics and automation have affected every aspect of our live and changed the way we used to live. Future of the Construction Industry is moving towards robotics, and automation of its processes; Rendering of Walls is one of them, which needs much improvement in its application process. As this process is part of every construction project and is very important, but time consuming and tiresome.

So, entering in the era of automation of construction industry this Automatic Rendering Machine is the first step towards easing and automating this process of rendering.

- This machine is unique and the first and foremost solution for making rendering process easy, quick and safe, which can revolutionize the construction industry in our country.
- This makes rendering process easier, faster, and effortless as compared to manual application.
- It has less or no material wastage.
- The machine works with conventional plaster material i.e., (stucco/cement mortar)
- The machine has the capability to be made more automated for usage at any place like large buildings, walls having uneven floors, danger for mason etc.

Future Recommendations

- Keeping in view the current advancements in robotics sector, this machine can be easily integrated with a mobile robot for fully automated functionality.
- At this point, this machine can only plaster walls in vertical direction. A horizontal rail can be added for motion in both horizontal and vertical directions.
- Swarm robotics is a fairly newer concept in robotics where multiple robots break down a large task into smaller tasks and then each robot performs its task. This concept can be used with our robot to render large buildings.
- The lifting mechanism of machine can be used for other purposes like material handling by modifying plastering head appropriately.

REFRENCES

Arivazhagan.B, (28-Jul-2014), Automatic Plastering Machine, International Journal of Advanced Research in Electronics, Communication & Instrumentation Engineering and Development, Volume: 2 (Issue: 2)

P.Keerthanaa1, K.Jeevitha2, V.Navina3, G.Indira4, S.Jayamani5 (2013) , AUTOMATIC WALL PAINTING ROBOT, International Journal of Innovative Research in Science, Engineering and Technology, Vol. 2, Issue 7

http://www.ratedpeople.com/c/advice/trade-insights/insights-plastering-and-rendering/difference-between-plastering-and-rendering

http://www.swivl.com/wp-content/uploads/2015/03/18365-plastering-machine-plaster-machine-painting-machine-rendering-machine-spraying-machine.pdf