

# **Design and Development of Roof Tile Production Mechanism Using Advanced Embedded Processor Control**

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**ABSTRACT:** Automation plays a vital role in simplifying complex process and procedure. The manual production of roof tile is made automated in this work, the time consumption and operating cost are reduced. In this work semi-automation of roof tile production is replaced fully with automated mechanism. When compared with the existing methodology of producing tiles, this proposed system enhances the quality of tiles. It works in temperature around 300 K. This machine has capacity to produce 10 tiles/min and 456 tiles/hour including of charging and discharging of raw materials. This machine produces machine moulded tiles with high capacity of insulation comparing with ground mould and table mould tiles. Flexure strength is 48.97Kg/cm<sup>2</sup> and water absorption capacity is 13.14%. The result shows that the qualities of tiles are improved.

**KEYWORDS:** Tiles, Extruder, Mixer and Embedded Control

## **I. INTRODUCTION**

The origin of clay roofing tile is traced independently to two different parts of the world, China and the Middle East. From these regions, the use of clay tile has spread throughout Asia and Europe. Tile making machines were first patented in the 1870s, and although much roofing tile continued to be made by hand, by the 1880s more and more factories started to use the machines. These fire codes, which remained in effect for almost two centuries, encouraged the use of tile for roofs, especially in urban areas, because of its fireproof qualities. Clay roofing tile was also preferred because of its durability, ease of maintenance, and lack of thermal conductivity.

Clay roofing tiles fell out of fashion again for a short time at the end of the 19th century, but once more gained acceptance in the 20th century, due primarily to the popularity of the Romantic Revival architectural styles, including Mission, Spanish, Mediterranean, Georgian and Renaissance Revival in which clay tile roofs featured prominently. With the availability of machines capable of extruding clay in a variety of forms in large quantities, clay tiles became more readily available across the nation. The accurate dating of early roofing tiles is difficult and often impossible. Fragments of tile found at archeological sites may indicate the existence of clay tile roofs, but the same type of tile was also sometimes used for other purposes such as paving, and in bake ovens. To further complicate dating, since clay tile frequently outlasted many of the earliest, less permanent structures, it was often reused on later buildings.

In 1939, apparatus for making roofing tiles was done by D. Brown Et Al, based on the above concept the roofing tile was made to have longitudinal edge interlocking between adjacent tiles, in order to have no seepage of water<sup>[1]</sup>. Similarly, in 1950, G.W. LAN'S "Machine for making roofing tile" a variety of interlocking patterns have been established to provide strong and robust water proof tiles<sup>[2]</sup>. In other model proposed by M.C. Willis "Roof tile making machine" a fool proof mechanism to reduce the manufacturing parts has been incorporated to make French tiles<sup>[3]</sup>. From John B Mordock's proposed concept "The roofing or siding article" a high thermal insulating siding or roofing material has been developed. The tile has been coated with Sun and moisture proof coating such as asphalt and roofing granules<sup>[4]</sup>. In 1996, Bhusankumar's model "Improvements in roof tile making machine", concrete tile has been made by roller and slipper method with pallets being fed from hopper<sup>[5]</sup>.

## II. MATERIALS AND METHODOLOGY

### A. Materials

The materials used for these work are as follows lead screw setup(with blade design), spur gear setup and extruders. The supporting structure is made up with cast iron and the conveyor is made up with stainless steel. Pneumatic cylinder is used for cutting tiles. 3hp and 5hp motor are employed for proper mixing. The main electronic components used are ATMEEL 89C51, relay and ULN 2003A.

### B. Mechanical design

Materials like clay, calcium oxide, colouring agent, cement and water are the components required to make the tile. It has two blades rotating in an opposite direction, getting power from a 5hp motor through a shaft. First the mixer component is mixed well in a proper manner. Then comes a lead screw setup in the extruder, running with 3hp motor using a spur gear setup containing rotating blades in the tail end, arranged with lead screw so that the mixture component is transferred to extruder 2. A pair of spur gears driven by a 3hp motor is used to accomplish the process of extrusion in extruder 1 to extruder 2. A roller is used for pushing the mixture component to the conveyor. This work process line diagram with control module is shown in

Fig.1. Initially, lubricating oil is spread over all the inner sides of tiles to allow smooth movement of tiles in the conveyor tray.

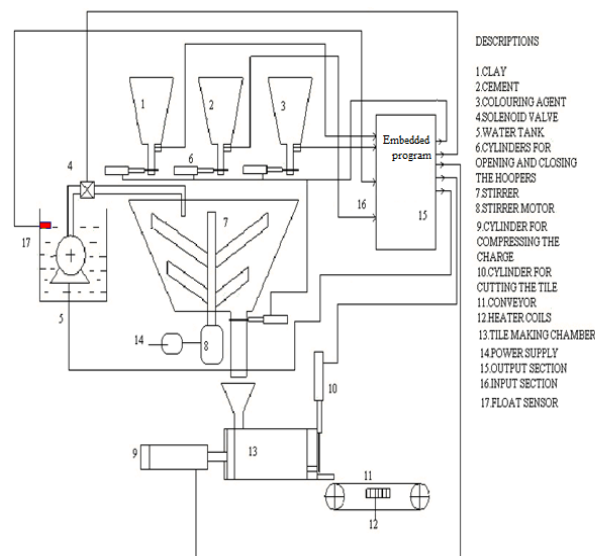


Fig.1 Line diagram – control module

### C. Experimental procedure

These are blended together using a pan mixture (Mixing chamber). In the mixing chamber two lead screw arrangements were present to uniformly mix the dough. Fig. 3 Lead screw mechanism with blade design. At the same time the dough is extruded from the mixing unit and then the dough is filled in the extrusion chamber (Extruder-I) through the charging door. The lead screw arrangement present in the chamber forces the mixture through the opening available at the front side of the chamber. The dough is again passed to the second extrusion

chamber (Extruder-II) to remove the moisture present in the dough.

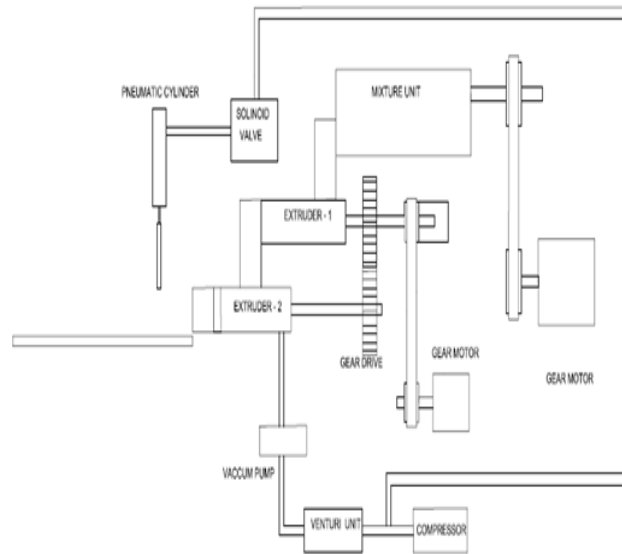


Fig. 2 Line diagram of mechanical assembly unit

This dough mixture is extruded through the opening provided in its front end. This opening is provided based on the type of the design required in the tile i.e., the shape of the tile. There is a plate outside the extrusion chamber near the opening to collect the extruded mixture. A cutter is placed above the outlet of the extrusion chamber to cut the extruded mixture, after the extrusion reaches the specified length. A pneumatic cylinder along with direction control employed for this operation. Fig. 2 Line diagram of mechanical assembly unit. The mixture is then transferred through heater module and the material is kept in movement for the time period set by the Embedded system programming and it depends on the type and size of the roof tile. The obtained final product is passed through the conveyor for storage.

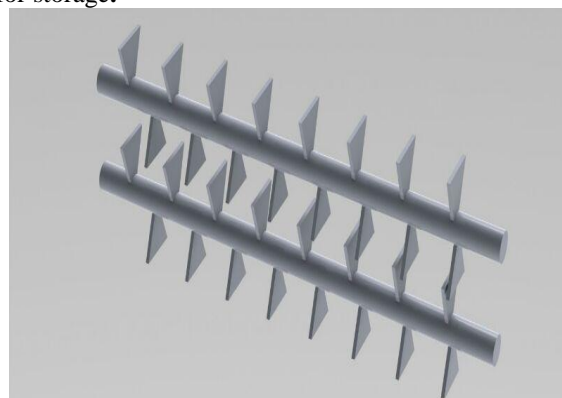
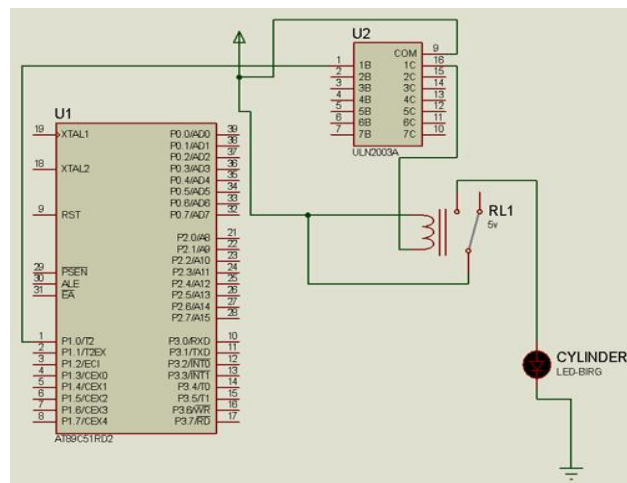


Fig .3 Lead screw mechanism with blade design

**D. Controller implementation**

The following mechanical setup is used in the project for extrusion of the mixture of clay, sand and water in a proper manner. The tile is cut into perfect shape through pneumatic cylinder actuated with electronically controlled solenoid valve (5/2 DCV). Then based on the timing sequence in embedded program, the microcontroller gives a control signal to direction control valve which in turn sends an actuation signal to the cylinder. The moving extruded tile is lubricated with an oil, so without any external power in the conveyor it moves freely in the tray and gets collected in the delivery place. This type of tiles is called machine mold. Basically, machine mold tiles have high capacity of insulation comparing with ground mold and table mold.

It consists of relay and relay driver IC ULN2003A in electrical setup actuation of Pneumatic cylinder actuated by direction control valve used in the system Fig 4. Electrical circuit diagram in proteus model. It sucks the moisture content and air present in the system, so it is easy in cutting tiles. The cutting tile actuation is done through programmed embedded concept. It cuts the tiles in perfect shape and exact dimension through the timing sequence in the controller.



**E. Design calculation**

Electrical,

For Timer

- 1 instruction = 0.0025 micro sec
- 15000 instruction = 1 sec
- 9000000 instruction = 1 min

Mechanical,

Pneumatic Cylinder

Force,  $P = F/A$

Where,  $F = (6 \times 10^5) \times (1.884 \times 10^{-3})$   
 $= 1130.4 \text{ N}$

**II. RESULT AND DISCUSSION**

This work is more efficient than the conventional machine. The above table.1 shows that when compared with conventional machine it is more efficient in thermal insulation and time consumption. The conventional machine takes more time to cut one tile, but this work has an approach of cutting two tiles at a time, so time consumption is less when

compared with conventional one. Skilled labour is unnecessary in the project, so it's more efficient than the conventional machine. Production of tiles is more when compared with conventional machine, because in this work a technique in which two tiles can be cut at a time is used, so that production is comparatively more in project. Then this approach has a great quality of tiles with thermal insulation and maintains a perfect temperature in place<sup>[4]</sup>. This work adopts an approach of using tiles of eco-friendly nature of the asphalt is more harmful when reacted with sun and affects human health<sup>[4]</sup>. So going for an eco-friendly mixture will not affect human health and atmosphere. The experimental setup is small in size compared with the conventional machine. Large setup is not portable and error finding of component is difficult. In a large machine initial cost of installation is high, so with smaller number of components, we have constructed an efficient machine for producing tiles with less number of work parts arranged in a machine.

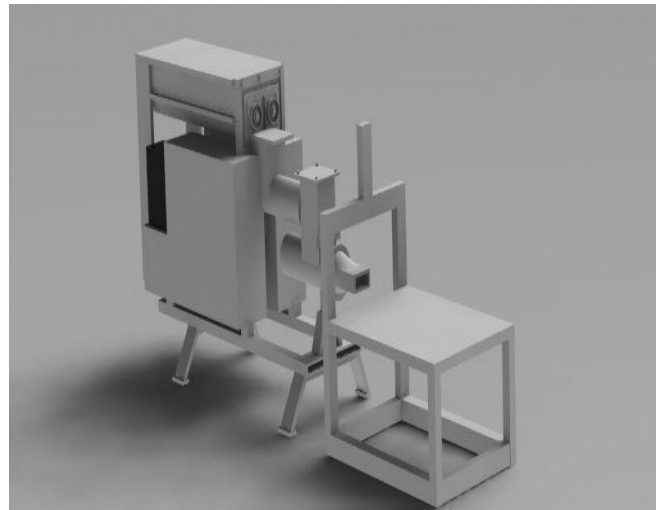


Fig.4 Solid Wok model of roof tile machine

The conveyor setup is simplified in the project. The movement of tiles is based on the oil in the extruder, it makes oil on the four sides of tiles, and the roller setup before cutting action takes place in the machine that moves through the tray in perfect shape and cuts precisely.

Flexural Strength and water absorption test shown in table.2 to check the quality of tiles. It has high quality of tiles as per IS2690

Table.1 concrete and roof tile making machine

| Sl.no | Description      | Concrete roof tile Machine              | Roof tile making Machine               |
|-------|------------------|---|--|
| 1.    | Time consumption | 6 tiles /min                            | 10 tiles /min                          |
| 2.    | Production       | 418 tiles/hr                            | 456 tiles /hr                          |
| 3.    | Skilled labour   | Needed                                  | Not necessary                          |
| 4.    | Thermal quality  | Fal-G - c sand. Thermal Quality is poor | Improved by using Soil - Cement Blocks |

Table.2 Test report of roof tile machine

| Sl.No                                  | Flexural Strength Kg/cm <sup>2</sup> | % of Water Absorption | Remarks                        |
|--|--------------------------------------|-----------------------|--------------------------------|
| 1.                                     | 45.18                                | 10.02                 | As Per IS 2690 (Part 1) : 1993 |
| 2.                                     | 43.80                                | 9.56                  |                                |
| 3.                                     | 48.55                                | 13.63                 |                                |
| 4.                                     | 49.99                                | 11.07                 |                                |
| 5.                                     | 52.46                                | 13.63                 |                                |
| 6.                                     | 50.51                                | 15.70                 |                                |
| 7.                                     | 47.93                                | 13.63                 |                                |
| 8.                                     | 52.57                                | 14.97                 |                                |
| 9.                                     | 49.48                                | 16.12                 |                                |
| <b>Average: 48.97Kg/cm<sup>2</sup></b> |                                      | <b>13.14%</b>         |                                |



Fig.5 Roof tile production machine

#### IV. CONCLUSION

This work can reduce time consumption and reducing manual effort. The Automatic roof tile making machine is highly useful for making tiles. We have an approach of producing tiles in less time consumption and more tiles are produced with less human intervention.

This work is cost effective as the labour cost is minimized. It is time efficient. This reduces the work load of the workers, thereby reducing their burden. Further has an approach of cost reduction in tiles and to enhance mass production. Then flexure strength and water absorption test has conducted to check the quality of tiles

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