

Newly Developed Automatic Lay-Up Process for Manufacturing of FRP Sheets

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Abstract:

Hand lay-up process is fabrication process to manufacture of FRP products. FRP or fiberglass corrugated roof sheet also manufactured by hand lay-up process, but some problems has been arise with this method such that, mainly low production rate of sheets; uniform thickness not maintaining; lay-up does not uniformly perform, resin is harmful for human. These problems can be eliminated by hand lay-up process converted into Automatic lay-up process with providing safety environments for works. In this paper also discussed about different composite materials of methods for manufacturing of roof sheet and other products.

Keywords: Corrugated roof sheet, Composite materials, FRP, Fiberglass, Hand lay-up, Gantry structure, Automatic machine.

1. Introduction

Now days, the Fiber Reinforced Plastic (FRP) products are generally manufactured by the Hand Lay-up or spray-up process. Hand Lay-up process is a simple method and economically cheap process w.r.t. other methods of FRP product manufacturing. The paper describe about automatic lay-up method of manufacturing of corrugated fiberglass roofing sheets, now days, manufacturing by Hand Lay-up process, this process done by manually with the help of equipments, it consists of open mold, brush, squeeze roller. Fiberglass is the composite material of resin and chopped fiber strand or fiber mats. This process is simple and economical for production of FRP product, but some problems are arise from these process such that,

- Production rate of corrugated fiberglass sheet is low i.e. approximately 50-60 sheets per day (i.e. 12 hr. shift.),
- Thickness of sheet is not uniform.
- Lay-up process does not perform uniformly i.e. when perform lay-up of resin on mold; the amount of resin is not taken with specific amount for lay-up on mold surface.
- Resins are harmful to human.
- Fiberglass strand does not uniformly sprayed on mold, therefore, strength of sheet does not uniform on sheet.

These above problems are eliminated; Hand lay-up process is converted into Automatic Lay-up process.

1.1. What Is The Hand Lay-Up Process?

Hand Lay-up is fabrication process of FRP products (Fiber Reinforced Plastic). The FRP is composite material of Resin and Fiberglass strand or Fiberglass mat. It involved building up layers of chopped glass or woven glass mat impregnated with catalyzed resin around a suitable mould. The reinforcement is then rolled for better wet-out and removing trapped air.

1.2. Steps of Hand lay-up process

Hand lay-up process is an open mold process. It is a simple process to manufacturing of FRP products
Preparing Mold:-

We take mold and removing any dust and dirt from mold. The mold material may be plaster, wood or new fiberglass, apply soft wax, P.V.A. and buff with soft towel.

- **Applying Resin:-**

Resin is applied on mold by the brush. The brush is move like to painting of wall.

- **Lay-up of Fiberglass:-**

Brush is applied of resin on mold then chopped fiber glass strands spread over the resin layer.

- **Applying Resin:-**

Again apply the resin layer over the glass strand layer by using brush.

- **Squeeze Action:-**

Second layer of resin is applied then roller is move over the layers of resin-fiberglass-resin, for removing the air between in layers. This action called squeeze action. This squeeze action also used for compact the product.

- **Remold :-**

Lastly the sheet is removing from mold for hardening of sheet, the left in air at room temperature. And remold product is final of a corrugated fiber roofing sheet. We ask that authors follow some simple guidelines. In essence, we ask you to make your paper look exactly like this document. The easiest way to do this is simply to download the template, and replace the content with your own material.

2. Literature Review:

The main purpose of that paper, to improve the manufacturing method of corrugated fiberglass roofing sheet. Today's used manufacturing method of corrugated fiberglass roofing sheet of Hand Lay-up process is converted into Automatic Lay-up process. Today's in the market available of various types of corrugated roofing sheets with different materials such as Steel (G.I. steel), Plastic, Composite materials etc. composite materials of Cement fibrous, Fiber Reinforce Plastic. These different materials of sheets are manufactured by using different manufacturing methods. Like that, for Steel corrugated roofing sheets manufactured process by using roll forming method; for Plastic corrugated roofing sheets manufacturing process by using Extrusion method; for Cement fibrous corrugated roofing sheets manufacturing process by using Hatschek method; for FRP corrugated roofing sheets manufacturing by using Hand Lay-up or Spray Lay-up method.

Cement fibrous corrugated roofing sheets like to be fiberglass roofing sheets, the different between both sheets are made from different materials. Cement fibrous sheet is in the used cement materials for bounding the fibers. And FRP sheet is in used the resin for bounding the fiberglass. These both sheets materials group is belong to composite materials. The fiber is used in sheet for increase the wind strength of sheet. Different materials of sheets, so different manufacturing methods of these. Hashem Akbari, Ronnen Levinson, and Paul Berdahl [6], they are discussed about the methods for the manufacturing of Residential Roofing materials. Such that, shingles; Clay tiles; Concrete tiles; Metal roofing. In this paper discussed about climate of California, the demand for cooling energy, increasing roof solar reflectance reduces energy consumption in mechanical cooled building, and improves occupant comfort in non-conditioned buildings, with manufacturing methods and innovative methods for increasing the solar reflectance of these roofing materials. In cement fibrous sheets, the major components involved cement, water, silica, lime stone flour and fibers. The cement fibrous corrugated roofing sheets manufacture by different methods, AL Moselemi [1], to provide an overview of the different technologies that are currently in use to manufactured of cement fibrous sheets, the most popular technology used in fiber cement manufacturing is the Hatschek process and other processes are used such as Extrusion machine, Fourdrinier forming machine, Pour-on Technology, Wounder Board Process, Cement-Bonded particle board, Wood wool Boards, Block and Siabs. These technologies are currently used for manufacturing of cement sheets in factories. Hatschek process is very old method was developed in 1890's for production of asbestos cement product. Tony Cook [4], describes the details working mechanism about Hatschek machine process for manufacturing of fiber cement sheets. This method is helpful for film formation cement fibrous sheets in uniform thickness and flatness of sheet.

S. Delvasto, E.F. Toro, F. Perdomo [2], this are discussed about another technology for manufacturing of corrugated fiber reinforced cementitious sheets using Vacuum forming technology. The machinery used in cylinder forming process is simple; this technology appropriate for small scales of production and it is an environmental friendly low cost appropriate technology that does not need skilled labour. Ciarlini Sergio [3], the discussed about existing manufacturing methods and to improve the existing method for manufacturing of corrugated cement fiber sheet. In an existing method of corrugated sheets in find it microscopic discontinuities, formation of cracks, delaminations, breakages, these all drawback eliminated by improving and small changes in method for producing corrugated cement sheets. Bijkerk, Bakker and Deblauwe [5], in this paper invention about the finished product of fiber cements are protected from scuffing damage during storage, transport, handling and fixing or mounting. Therefore, to applied spacer of hot melt adhesive to the back side of finished product and described the manufacturing method for applying the spacer, to extend the Hatschek process which was originally applied to the asbestos cement technology. Above manufacturing methods and technology of to produce corrugated fiber cement sheets, these manufacturing technologies will be helping for to introduce the Automatic technology for manufacturing corrugated fiberglass roofing sheets.

3. Solution On Existing Systems Problems

In hand lay-up method arises above problems these problems are overcome by conversion of manually operated hand lay-up process into automatic lay-up process i.e. all operation steps are performed by the automatically using dedicated system.

Describe automatic systems are related to the existing system in following.

- [1] Preparing Mold:-
- [2] In existing system, removing of dust by soft cloth and apply wax and PVA by manually using soft towel.
- [3] In Automatic system, already die used dust free and PVA agent apply by spraying system on mold.
- [4] Applying Resin :-
- [5] In existing system, resin apply on mold with help of brush, the brush is move like to paint.
- [6] In Automatic system, resins apply by spray system or dumping of resin in mold.
- [7] Lay-up of fiberglass :-
- [8] In existing system, chopped fiber spread by hand on layer of resin.
- [9] In Automatic system, chopped fiber spread with help of fiber spread unit.
- [10] Again applying Resin:-
- [11] In existing system, second layer of resin applied on fiber with the help of brush. It is same like to first layer of resin.
- [12] In Automatic system, second layer of resin applied by spray system or dumping of resin in mold.
- [13] Squeeze Action:-
- [14] In existing system, squeezing action performs by roller applying hand force and move more layer of resin – fiber – resin.
- [15] In Automatic system, squeezing actions perform by automatic roller by self weight of roller for compacting and air releasing between layer of resin and fiber.
- [16] Remold:-
- [17] In existing system, after hardening of sheet, the remold by manually.
- [18] In Automatic system, the remold operation by using automatic ejection system to remove sheet from mold.

3.1. Required components for Automatic Lay-up System:-

- a. PVA Spray Unit.
- b. Resin Spray Unit.
- c. Fiber Spread Unit.
- d. Roller Unit for squeezing action.
- e. Ejection System.

4. Structure Of Automatic Machine

Structure is basic part of every machine for holding of all unit of any system. In Automatic lay-up system used gantry type of structure used for holding and performing of operations by separates units.

4.1 Construction of Structure:-

It consists of base table, columns, and guide ways rod. The base table is place on floor and four columns are mounted on table, at near about end corner of table. The column used for support to the guide ways rod shown in fig.1. These guide way rod used for the travelling the units on mold for performing operations.

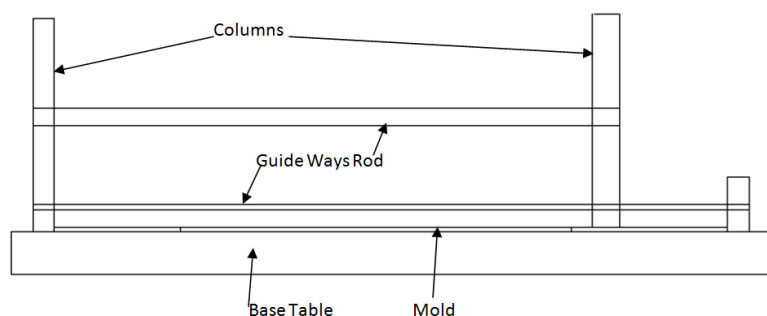


Figure 1 Basic Structure of Automatic Lay-up Process

5. Proposed System For Automatic Lay-Up Process

Three systems are proposed for Automatic lay-up process in following.

5.1. Proposed System “A”

Construction & Working of Machine: -

This system used in gantry type of structure it is shown in fig.2, it consists of base table, column, resin spray unit, PVA spray unit, flap system, fiber glass spread unit, roller unit, and mold. These arrangements show in fig.2, Base table mount on angle type of structure. Four columns are mounted on base table for supporting to guide ways rod. On this guide ways rod mounted spray units, flap system, fiber spread unit, roller unit for to travelling on mold for performing of operation simultaneously, with the help of motion mechanisms applying individual external sources. In this system three guide ways are used for holding units. On one guide way for fiber glass spread unit. Second guide way for flap and squeeze unit and third guide way for spraying unit.

Working of Machine:-

In this system, firstly applying the PVA agent on mold by using spray unit, these spray unit having two nozzle one for PVA and other for Resin. The spray unit move on y-direction of guide way for dumping of PVA in mold like to paste, now, flap system is activated for PVA apply on mold uniformly. This flap taken initial position after completion of laying process of PVA. Whenever flap activated before that nozzle tip is rotate to 90° at shown in fig.2, for avoiding of accident, then flap move for performs of work. Now nozzle position is taken original after flap comes to initial position. The nozzle is ready for dumping the resin in mold when the spray unit moves to initial position i.e. backward moment. Again nozzle tip is rotate at 90° . Flap is ready for perform the lay-up operation on mold. After completion of lay-up of resin operation the flap comes to initial position. Now, fiber glass spread by spread unit this units are place to other end of table i.e. left end it is shown in fig.2, after completion of fiber spread operation these comes to origin position. Next step is again activated resin nozzle for dumping of resin in mold same to move of spray unit in y-direction but now the completion of spraying of resin the unit comes to origin position, and taken rotate at 90° . Flap is move for performing of lay-up operation on fiber glass layer. Now, flap stop at the other end. The next step is squeezing operation by using roller units. The roller units move on layer of resin-fiber-resin for releasing of air and compacting of product. This roller unit two times of performing squeezing action, one forward direction and second is backward direction. Lastly roller unit comes to origin position as well as flap also comes to origin position, after hardening of sheet remove from mold. This cycle is repeated for manufacturing of sheets.

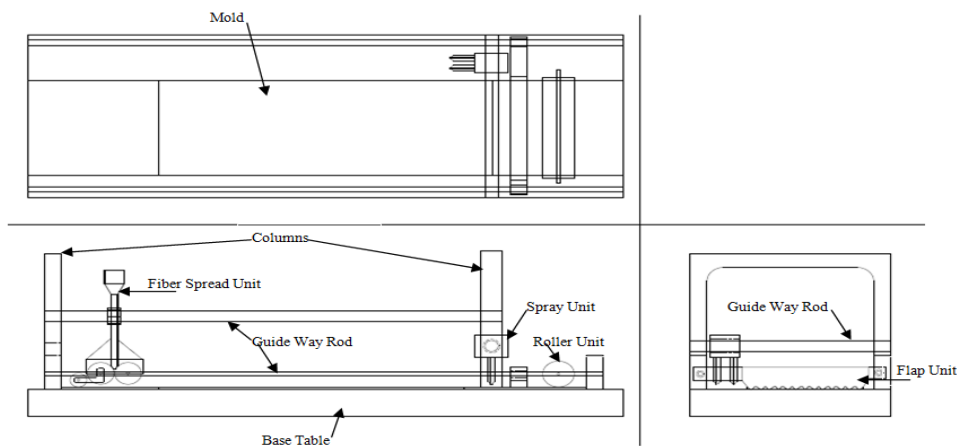


Figure 2. First Proposed System for Automatic Lay-up Process

5.2. Proposed System “B”

Construction & Working of Machine: -

In Second proposed system construction is same near about to first proposed system. The little change is spray unit motion and number of nozzles for dumping of resin in mold. In this spray unit move in vertical direction like up and down for dumping of resin in mold. It is shown in fig. the PVA nozzles and Resin nozzles are arrange to opposite side its shown in fig.3, first pair of PVA nozzle dump PVA in mold. Before that spray unit rotate 90° for avoiding accident and move the flap used for performing uniform lay-up operation. After that completion of lay-up for PVA. Now, spray unit rotate next at 90° and ready for dumping of resin in mold. After dumping of resin operation the spray unit again rotates at 90° , and flap activated for lay-up operation. After that the spray unit moves upward direction in vertically, place origin position of spray unit. Now, fiber glass spread

unit activated for spreading the fiber on first layer of resin, completion of fiber spreading operation, again dumping the resin in mold and lay-up by flap system. After that roller unit is activated for performing squeezing action. This cycle is repeated for manufacturing of sheets. In this system, two guide ways are used for holding and travelling of units for performing lay-up operation for manufacturing of sheets. One guide way rod is used for fiber spread unit and second guide way rod for flap system and roller system shown in fig.3.

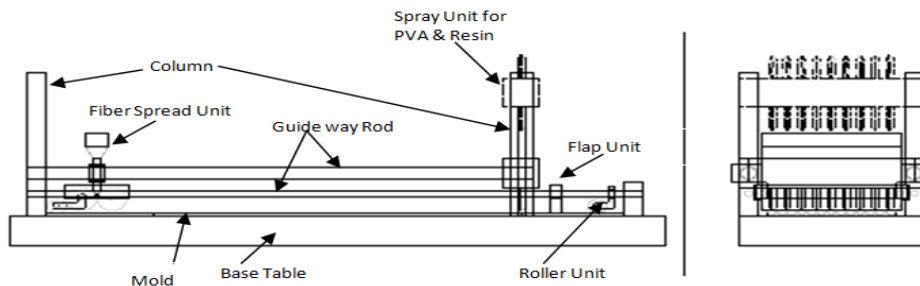


Figure 3. Second Proposed System for Automatic Lay-up Process

5.3. Proposed System “C”

Construction & Working of Machine: -

In third proposed system construction same like to above two systems. But in this system used only one guide way rod for holding and travelling of units for performing operation steps for manufacturing of sheets. On these guide way rod two spray units, one fiber spread unit, one rolling units are mounted. The two spray unit and fiber spread unit are place at right end of table and roller unit is placed at left end of table shown in fig.4. Working of these systems, firstly spray PVA on mold by spray unit, the moment of unit right to left direction and stop the unit at left end of table, after that resin spray move for spraying on mold in same direction of previous unit and stop there. Now, fiber glass spread unit ready for spreading of fiber on layer of resin, these unit move from right to left direction, and return to original position. Again spray the resin on layer of fiber glass by resin unit whenever these unit move to backward direction and takes the origin position. Now, PVA spray unit return to origin position but these time no any operation perform i.e. ideally move. After roller unit activated for performing of squeezing action for releasing of air in between layer of resin-fiber-resin, also compacting of product uniformly. These roller units perform squeezing action twice, and reset the origin position. This cycle repeated for manufacturing of sheets.

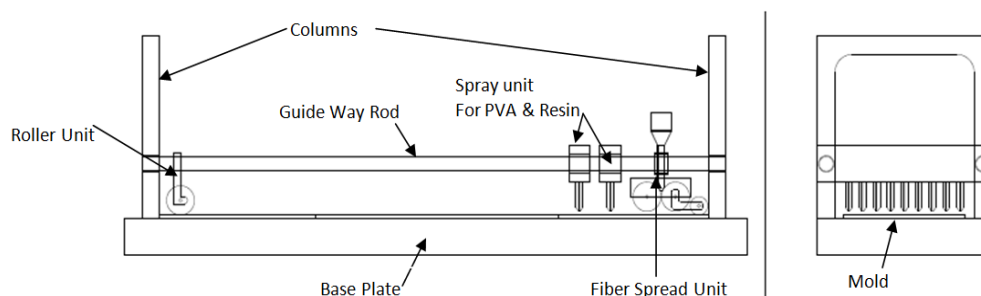


Figure 4. Third Proposed System for Automatic Lay-up Process

6. Conclusion

It is possible to existing lay-up process converted into Automatic Lay-up Process. Therefore, those problems are arise in existing lay-up process can be avoided with increasing the production rate of sheets. There, three systems are proposed for automatic lay-up system, so, can be possible to adopt these one from above system and also available more options for converting Automatic Lay-up system. If adopt the automatic lay-up process for manufacturing of FRP sheets, therefore achieving the uniform thickness of sheet as well as to providing safety environments to human. Also increasing the production rate with economical.

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