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# Overview of Hand Layup FRP Molding Process

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**Abstract:** *This paper is dealing with the hand layup process used in FRP manufacturing. Fiber reinforced polymer commonly known as FRP is a composite material made of a polymer matrix rainforest with fiber. Composite Materials are becoming more popular gradually replacing traditional material with additional strength, lighter weight and superior property. Fiber reinforced composites used in water transport, construction industry, toys, instrumentation, medicine etc. Based on application and reinforcement used, there are many ways to manufactures parts with fiber reinforced composites, the fiber is usually glass carbon or aramid, although other fiber such as or wood or asbestos have been sometime used. FRP are manufactured by two methods: pultrusion and hand layup as open mold method. Hand layup is open molding process and it's the oldest moulding process for creating FPR product. In this process no technical skills or complex machine needed its ideal for low volume. labor intensive, larger products such as vessel, tanks, car bodies, and oil pipeline. as the name suggests, this process is all done by hand so the quality really depend on the persons skill in crafting FRP. Hand layup is an open molding method suitable for making wide verity of composite product from very small to very large. Production volume per mold is low however it is flexible to product substantial production quantity using multiple molds. Hand layup is simple composite molding method, offering low-cost tooling, simple processing, and wide range of part size..*

**Keywords:** FPR, hand layup

## I. INTRODUCTION

Fiber-reinforced plastic (FRP; also called fiber- reinforced polymer, or fiber-reinforced plastic) is a composite material made of a polymer matrix reinforced with fibers. The fibers are usually glass (in fiberglass), carbon (in carbon fiber reinforced polymer), aramid, or basalt. Rarely, other fibers such as paper, wood, or asbestos have been used. The polymer is usually an epoxy, vinyl ester, or polyester thermosetting plastic, though phenol formaldehyde resins are still in use. [1]. FRPs are commonly used in the aerospace, automotive, marine, and construction industries. They are commonly found in ballistic armor and cylinders for Self-contained breathing apparatus .Fiber- reinforced plastic (FRP; also called fiber-reinforced polymer, or fiber-reinforced plastic) is a composite material made of a polymer matrix reinforced with fibers. The fibers are usually glass (in fiberglass), carbon (in carbon fiber reinforced polymer), aramid, or basalt. Rarely, other fibers such as paper, wood, or asbestos have been used. The polymer is usually an epoxy, vinyl ester, or polyester thermosetting plastic, though phenol formaldehyde resins are still in use.[2]

The history of modern fiberglass is can be referred back to the 1930s.in 1907 the first Bakelite was establish after which plastic industries had grown and plastics a start of frp industry . in 1941 Henry ford used frp composite in automobile industry .[3]

Fiber-reinforced polymer composite offers not only high strength to weight ratio, but also reveals exceptional properties such as high durability; stiffness; damping property; flexural strength; and resistance to corrosion, wear, impact, and fire.[4]

Fibre reinforced polymer (FRP) are composites used in almost every type of advanced engineering structure, with their usage ranging from aircraft, helicopters and spacecraft through to boats, ships and offshore platforms and to automobiles, sports goods, chemical processing equipment and civil infrastructure.

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Composite is a combination of two main element one is called matrix and the other is called reinforcement. Composite can be divided into mainly three category a. PMC (Polymer Matrix Composite), MMC (Metal Matrix Composite) and CMC (Ceramic Matrix Composite). When fibers are combined with resin or plastic they become fiber reinforcement plastic (FRP) composites. [2] The parts made with FRP composite materials have remarkable advantages over traditional materials such as light weight with high strength, good corrosion resistance, dimension stability, good impact resistance, durability, easy mould ability etc. This paper will help to compare different manufacturing process available and get a thought about which process is preferred for which kind of product application and why. The history shows how the different process were developed and grown over years. This paper gives an bird eye view of hand lay up manufacturing processes available in FRP industry with other with respect to its advantage, limitations, application, types of fibers, types of resin system, quality of part required, cost and production rate.

## II. Manufacturing Method

1. CONTIUOUS FIBER
   - **a.** Open Mould
     - **i.** Hand layup
   - **b.** Closed Mould
     - **ii.** Compression
     - **iii.** RTM - VARTM
   - **c.** Filament winding
     - **iv.** Automated tape winding.
   - **d.** Pultrusion possess
   - **e.** Other process
     - **v.** Tube rolling
2. SHORT FIBER
   - **a.** Open Mould
     - **vi.** Spray method
   - **b.** Close Mould
     - **vii.** Compression,
     - **viii.** Transfer Moulding
     - **ix.** Injection Moulding
   - **c.** Other
     - **x.** Centrifugal casting

## III. Hand Layup Method

The simplest and oldest of the fabrication process for frp / composite, hand layup, is use in low volume production of large compnant such as bolt hulls and associated part [6] Hand layup method is the oldest FRP molding method for making FRP GRP composite products. It does not require technical skills and machinery. It's a way of small volume and high labor intensity, especially suitable for large parts such as FRP vessel. Half of the mold is usually used during composite layup process. The figure below shows the typical structure of the hand layup composite.

The mold have the structural shapes of the FRP products. In order to make the product surface shiny or textured, the mold surface should have a corresponding surface finish. If the outer surface of the product is smooth, the product is made inside the female mold. Likewise, if the inside must be smooth, then molding is done on the male mold. The mold should be free of defects because the FRP product will form the mark of the corresponding defect.

Because the resin used is highly viscous, the product may stick to the mold. There should be a suitable release mechanism. Product release may be affected. By using the layer of wax or polyvinyl alcohol (PVA), or a thin film like polyester film (Mylar). Composite layup process is not suitable for complex structural shapes because Mylar sheets must fit into the mold GRP profile

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### 3.1 Gel coat

A pigmented gel coat is first spray onto the mould for high quality surface . Gel coat gives you the smoothness required for the fiberglass product. It is usually a thin layer of resin that is about several mm on the surface of the product. Adding proper pigments to the resin, and then the color is obtained. The gel coat forms a protective layer to protect the fiberglass from contacting with water and chemicals. If it is too thin, the fiber pattern will become visible. If it is too thick, there will be crazing and star cracks on the tape.

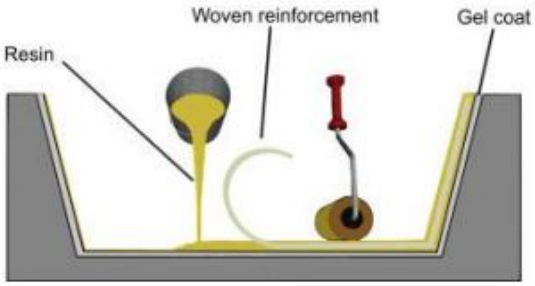


Fig. 1. Step 1 Gel coating

### 3.2 Surface Mat Layer

When the gel coat has cured, glass reinforcing mat and woven roving is placed on the mould and the catalyzed resin is poured, brushed or sprayed on. The surface mat layer will be placed under the gel coat. The fiber of the mat is not as strong as the reinforced fiber, but the mat provides the anti-crack and impact strength for the rich resin layer. This is an optional layer that is only used in a particular situation.

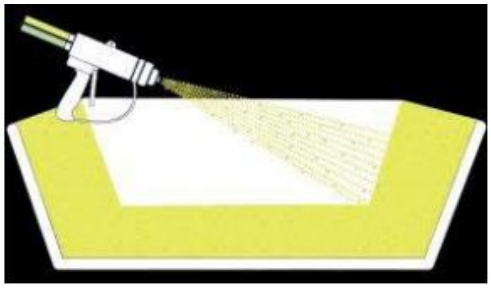

Fig. 2. Step 2 adding rainforcing mat

### 3.3. Glass Fiber Laminate

Manual rolling removed traped air the FRP/Composite and throughly wets the reinforcement with the resin. The resin wetted glass fiber layer shall be laid in sequence until the required thickness is reached. The finished material is called a lamination. Laminate gives the fiberglass product strength and rigidity. Glass fibers in the chopped strand mat (CSM) are usually used for obtaining composite material products. Woven roving, one-way mat and two-way mat are also used for acquiring high strength composite materials.

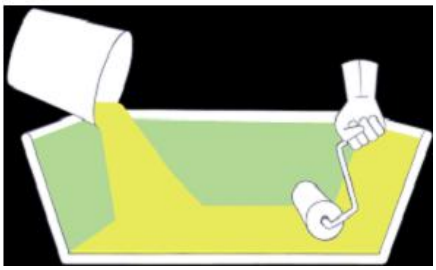

Fig. 3. Step 3 manual rolling

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### 3.4. Surface mat layer/resin coating

The resin wetted glass fiber layer shall be laid in sequence until the required thickness is reached. The finished material is called a lamination. Laminate gives the fiberglass product strength and rigidity. Glass fibers in the chopped strand mat (CSM) are usually used for obtaining composite material products. Woven roving, one-way mat and two-way mat are also used for acquiring high strength composite materials.

Additional layers of mat or woven roving and resin are added for thickness . a catalyst or accelarator initiate curing in the resin system which hardness the frp / composite without external heat . [7]. this frp hand layup process required low cost tooling , simple processing and a wide range of part size potential . design change are made easily with this process . part have one finish surface and required secondary trimming

## IV. Hand Layup Process

Gel coat is first applied to the mold using a spray gun for a high quality surface. When the gel coat has cured sufficiently, roll stock fiberglass reinforcement is manually placed on the mold. The laminating resin is applied by pouring, brushing, spraying, or using a paint roller. FRP rollers, paint rollers, or squeegees are used to consolidate the laminate, thoroughly wetting the reinforcement and removing entrapped air. Subsequent layers of fiberglass reinforcement are added to build laminate thickness. Low density core materials such as end-grain balsa, foam, and honeycomb, are commonly used to stiffen the laminate. This is known as sandwich construction .

## V. About The Moulds

The opening process of FRP manufacturing uses a male or female mold. The moulds can be finished by using Paris, wood, fiberglass or metal as material in hand lay up method. Paris mold gypsum is one or at most two, because the mold may break during the release of the fiberglass product. Wood modules need to be completed at each molding cycle. The glass steel mould is the ideal choice for complex shape. Metal molds are preferred when heating and pressing are needed.

## VI. Advantages

This is a low-volume, labor-intensive method. It's suitable for many fiberglass reinforced plastic products, such as FRP vessel, fiberglass car bodies, FRP pipe, FRP tank, furniture, corrosion resistant FRP equipment. No expensive machinery is necessary. Almost all shapes and sizes can be made. The color and texture can be obtained through the hand layup method. Choosing composite layup process as a FRP process. As a GRP manufacturing method, the following conditions are good for hand lay up. Only one side needs to have a smooth surface. The product has large size and complex shape. Only a small amount of components are needed.

## VII. Limitation

The quality of the FRP product depends on the operator's skill. Not suitable for mass fiber glass production of high-speed small products. It is hard to obtain a free- space composite material

## VIII. Application

The largest number of reinforced plastics composite products are produced by the hand lay-up process. A few examples of this processes uses are: boats, portable toilets, picnic tables, car bodies, diesel truck cabs, hard shell truck bed covers and air craft skins and interiors. Following are some other product

1. Wind turbine , blades , boats , architectural shape .
2. Secondary structure in aerospace composite .
3. Automobile parts , dash board and deck .
4. Car bodies, diesel truck cabs, hard shell truck bed covers and air craft skins and interiors.

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