CHAPTER 4

FABRICATION OF COMPOSITES

4.1 Methods of Fabrication Process

4.1.1 Spray Method

In this method, the fibers are made in to small and in equal proportion and it is fed in to the spray of resin directly into the mould. The fibers are deposited on the resin which cured at atmospheric temperatures. Even though it is very low cost and quick deposition among the reinforcement and the medium, only short fibers can be imposed in this method to fabricate the composite laminate for mass production and it is very easy to manufacture and it is easily available.

4.1.2 Hand Layup Method

In hand layup method, resins are impregnated into fabrics by manual feed which is mainly of roving form. The fibers and resins are impinged on the surface with the help of the rollers which has been fed into the mould. Then the fibers are made free under standard atmospheric conditions. This method is very simple and easy but it requires high skill to fabricate the composite.

4.1.3 Vacuum Bagging

This method is also known as wet layup process. Here, pressure is applied to the laminated by sealing a plastic film over the wet laid up laminate. The air under the bag is exposed by a vacuum pump and then the fibers are consolidated with one atmospheric pressure to form the laminate. High fiber content can usually be achieved by this process. The vacuum bag can avoid
blow holes but the mixing of resin is controlled and determined by the operator and it is very difficult to dispose.

4.1.4 Filament winding

This method is primarily used for pipes and tanks. Here, fibers are passed through a resin bath which is controlled by feeding mechanism and the rate of rotation of the mandrel. This method is very fast and economic and the process is limited to convex shaped components. Only lower viscosity resin can be used for health and safety purposes.

4.1.5 Pultrusion process

Fibers are retrieved from creel with the help of a resin bath through a heated die. The impregnated fiber in the die makes the final shape of the product. Then the product is cut into desired shapes and length. It is a continuous process having a uniform cross section can be implemented in this process. This process is accurate and the cost is minimal which is taken from a creel but it is limited to constant cross section components and the heating die cost is very high.

4.1.6 Resin transfer molding

Fabrics are laid up in dry sequence which the fibers are pre pressed to the required mold shape. Then it is laid into the mould tool. Here, resin is injected into the cavity with the second mould tool is clamped over the first and then the vacuum is applied to the mould cavity. Finally, the injected mould is used at ambient temperature.

4.1.7 Compression molding process

It has two moulds as in the form of die in heated condition. Here, the fibers are placed in between the top and bottom mold and compressed to form
the laminate. The process of compression gets completed until the fiber and the resin are uniformly spread throughout the laminate. This method is produced more number of components of high production rate in automotive and manufacturing industries.

4.2 Fabrication Process of Composite

4.2.1 Hand layup method

This method is the conventional way of producing hybrid composites. The process involves and depends on operator skill, the hardness of the composite, cost, rate of production, and the shape of the composite. In this method thermosetting resin is used for the better interfacial bond among reinforcement and the medium. In this research work, the hybrid composites are fabricated by hand layup method. This method is very cheap and simple as the tools are used for fabricating the composite is also very cheap. For fabricating the composite, fibers for laying purpose, liquid resin mixed with hardener, a silica rubber frame and roller is needed. This method is used for simple and low volume production.

4.2.2 Steps involved in hand layup method

![Image of Hand Layup Process](image)

Figure 4.1 Hand Layup Process
The materials used for fabrication process is shown in the figure 4.1. The fibers used are twisted Kevlar, twisted kenaf, and twisted neem in addition to that glass reinforced polymer fiber. Glass fibers are laid at the top and bottom most of the composite laminate for better finishing purpose. Three different categories with three samples have been fabricated using hand layup method. All the fibers are laid in normal direction and kept in dry condition before it is fed to the laminate. Initially, the releasing agent is applied over the surface in order to remove the laminate easily. After applied, a thin layer of resin is applied ad then the glass fiber is laid on the surface. A weight of 5 kg is placed over the glass fiber to remove air bubbles if any and it is kept undisturbed for about 3 hours. Also, fibers are also dried in the normal condition to make the fibers moisture free.

In category I, twisted Kevlar, twisted kenaf, twisted kenaf and twisted Kevlar are laid in sequence one on other. The first layer is twisted Kevlar is spread over the entire glass fiber having the length and width of 300mm. after, the resin mixed with hardener in the ratio 10:1 is applied on the surface of the first layer and rolled with the help of roller in such a way that the material is spread over uniformly thereby achieving homogenous structure. Then the second layer consists of twisted kenaf is laid on the surface and again resin is spread over and rolled. Then the third layer, again twisted kenaf is laid and the resin is applied and rolled. Now the glass fiber reinforced polymer is placed on the top of the surface for finishing purpose and also make an enclosed surface such that the fibers will not spread outside which makes entire setup as first laminate. In category II, twisted Kevlar, twisted Neem, twisted Neem and twisted Kevlar are laid in sequence one on other. The first layer is twisted Kevlar is spread over the entire glass fiber having the length and width of 300 mm. After, the resin mixed with hardener in the ratio 10:1 is applied on the surface of the first layer and rolled with the help of roller so that the composite has homogenous composition. Then the second layer
consists of twisted Neem is laid on the surface and again resin is spread over and rolled. Then the third layer, again twisted Neem is laid and the resin is applied and rolled. In category III, twisted Kevlar, twisted kenaf, twisted Neem and twisted Kevlar are laid in sequence one on other. The first layer is twisted Kevlar is spread over the entire glass fiber having the length and width of 300 mm. after, the resin mixed with hardener in the ratio 10:1 is applied on the surface of the first layer and rolled with the help of roller so that the composite has homogenous composition. Then the second layer consists of twisted kenaf is laid on the surface and again resin is spread over and rolled. Then the third layer, twisted Neem is laid and the resin is applied and rolled. Now the glass fiber reinforced polymer is placed on the top of the surface for finishing purpose. All the laminates are repeated for further two times so that three samples of each category are made.

a. Tools for fabrication  
b. Kevlar fiber  
c. Kenaf fiber  
d. Neem fiber
Hand layup process is the cheapest mode of fabricating the composite. Other methods like resin transfer molding, filament winding, pultrusion process needs skilled operator and result in high labor cost.
Table 4.1 Sequence of Composite Laminate

The various stages of hand layup method are shown in Figure 4.2. The composite laminate with three different categories and their sequence are shown in figure 4.3 and table 4.1 respectively.