What is FRP and Pultruded FRP?

Emergence of composite materials was a great development in the field of material engineering. Discovery of new type of composites led to the replacement of many traditionally used materials. Carbon fiber based plastics, glass fiber based plastics and other materials began to be used in high end applications like space, defense, aircrafts, robotics, special structures as well as in industries like automobile etc. These materials began to replace metals and cement based structures where high strength and light weight was the defining criteria. These materials can be fabricated with specified parameters like strength, shape and size, colour, durability, UV protection, impact resistance etc. Among these material Fiber Reinforced Plastic began to be used for constructing cooling towers because of its excellent properties well suited to cooling tower applications. With the emergence of newer fabrication techniques like FRP Pultrusion mass production ensuring highest quality in the factory became a reality. Now these materials are commonly used for building packaged cooling towers as well as big and high capacity cooling towers.

Reinforced Plastics

Reinforced Plastic is a class of composite material which contains fiber as reinforcement to the plastic body. The reinforcement gives desirable properties to the fabricated material. As the direction of the fiber reinforcement is changed or the plastic is changed properties of the resultant composite is changed. Apart from this additives can give additional properties like colour, UV protection, flame retardant nature, anti skid etc.

Pultrusion Process:

FRP sections for cooling tower are usually made by pultrusion process. This process creates continuous composite profile by pulling raw composites through a heated die. Pultrusion combines words “pull” and “extrusion” where extrusion is pulling of material such as fiberglass and resin, through a shaping die. The pultrusion process starts with racks or creels holding rolls of fiber roving. Most often the reinforcement is fiberglass, but it can be carbon, aramid, or a mixture. This raw fiber is pulled off the racks and guided through a resin bath or resin impregnation system. Many resin types may be used in pultrusion including polyester, polyurethane and vinyl ester epoxy resins etc. Resin can also be injected directly into the die in some pultrusion systems. The raw resin used is a thermosetting resin (hardens on heating), which is sometimes combined with fillers, catalysts, and pigments. The fiber becomes fully impregnated (wetted-out) with the resin such that all the fiber filaments are thoroughly saturated with the resin mixture. Then this is passed through “pre former” which is a tooling arrangement to squeeze out extra resin and organize the fiber into correct shape. The un-cured composite material is guided through a series of tooling. This custom tooling helps arrange and organize the fiber into the correct shape. Often continuous strand materials and surface veils are added in this step to increase structure and surface finish. Once the resin impregnated fiber is organized and removed of excess resin, the composite will pass through a heated steel die. Precisely machined and often chromed, the die is heated to a constant temperature, and may have several zones of temperature through-out its length, which will cure the thermosetting resin. The profile that exits the die is now a cured pultruded Fiber Reinforced Polymer (FRP) composite. This FRP profile is pinched and pulled by a “gripper” system. Either caterpillar tracks or hydraulic clamps are used to pull the composite through the pultrusion die on a continuous basis. At the end of this pultrusion machine is a cut-

off saw. The pultruded profiles are cut to the specific length and stacked for delivery.

FRP pultruded products are often stronger then a similar product manufactured by hand-layup, vacuum bag infusion, and other composite processing methods. During the pultrusion process, the many fiber bundles are pulled downstream using hydraulic or caterpillar grippers. Due to this pulling, the fiber filaments are in tension when curing in the heated die. When in tension, the fibers have higher strength values and are better aligned allowing good compaction, with more fibers fitting into a given volume. Fiber density is extremely high, as all excess resin is squeezed out before entering the die. Standard pultrusions can have fiber content of 50% by volume, 70% by weight, creating an extremely strong FRP composite.

Difference between FRP and GRP:

It has been seen that there is lot of confusion between what is FRP and what is GRP. Whether it is the same material or two different materials. As defined above FRP or GRP are both composite materials. FRP or Fiber Reinforced Plastic is the general name in which any fiber is used for making the composite material. That fiber can be glass fiber also. If glass fiber is used for making composite material it may be called **G**lass Fiber **R**einforced **P**lastic or GRP. Thus we can define both as under.

"*Fiber-reinforced plastic (FRP),* also known as *fiber-reinforced polymer*, is a composite material made of a polymer matrix reinforced with fibers. The fibers are usually fiberglass (many categories), carbon, aramid, boron etc while the polymer is usually an epoxy, vinylester or polyester thermosetting plastic. FRPs are commonly used in the aerospace, automotive, marine, and construction industries.

"Glass-Reinforced Plastic (GRP), also known as *glass fiber-reinforced plastic (GFRP)*, is a fiber reinforced polymer made of a plastic matrix reinforced by fine fibers made of glass. It is also known simply by the name of the reinforcing fibers themselves: **fiberglass**."

Finally we can say that FRP contains
1. **Fiber** like Glass, Aramid, Carbon, Ceramic
2. **Matrix of Plastic** like Polyester, Pthalates, Epoxide, Polyurethane, HDPE, PTFE etc.
3. **Additives** like Colours, Fire inhibitors, UV Retardants, Anti Skid, Conductivity etc.

FRP materials can be made in various ways. In terms of manufacturing methods and type and number of products manufactured, these are the most versatile materials. They can be moulded, pushed, pulled, profiled, rotated etc. The shape they can form is only limited by imagination.

Some of the FRP manufacturing methods are listed below:

1. Injection Moulding
2. Pultrusion
3. Pushthrusion
4. Casting
5. Filament Winding
6. And various other methods as per desired properties of final product