Pultruded fiberglass in cooling towers

General

Fiberglass, or glass fiber reinforced plastic, is the eponymous term for polymers reinforced by glass fibers. One fiberglass production technique is pultrusion, wherein glass fibers are fed into the machine, dipped in resin, pass through a mold that shapes them and heats them, and comes out the other side as a structural profile with a uniform cross-section. The fibers are coated and contribute the necessary strength to the material, while the resin provides homogeneity, enabling attachability and efficient use of the fibers' strength, as well as distributing the load over the fibers and protecting them from harsh environments.

Using pultruded fiberglass in cooling towers began 40 years ago, with the decrease in availability of the most common raw material at the time: wood. Since the 1990s, pultruded fiberglass has been the preferred material for site-erected cooling towers, over concrete, wood, or steel in its various forms.

Advantages of pultruded fiberglass in cooling towers

- Resistance to corrosion
- High strength proportionate to weight
- Low cost
- Simple and quick to erect
- Lightweight
- Low maintenance costs

Resin types and their corresponding functions under various working conditions

The resin (Polymer) in which glass fibers are dipped are of one of the following types:

- **Orthophtalic** – considered the most basic and least costly of the resin types. Its main use is in finishing, coating, roofing, and other cases wherein high structural strength is not required.
- **Isophthalic** – The commonest in use in cooling towers due to its combination of properties that prove optimal in cooling tower environments, such as high strength, resistance to extreme temperatures, and resistance to corrosion
- **Vinyl Ester** – considered the highest quality of the resins. Its properties are strength, temperature range, and superb chemical resistance. Vinyl ester is mainly used in processes entailing exposure to especially corrosive environments with very broad temperature ranges (-50° C. - + 130 ° C.), and stringent structural requirements.

Comparison of FRP properties and those of other materials

Below is a table showing properties of materials commonly used in construction:

Property	Wood	stainless steel	Plain steel	PVC	FRP
Density (kg/m^3)	0.52	7.9	7.8	1.4	2
Modulus Elasticity (GPa)	16	200	210	3	25
Tensile strength (MPa)	135	485	400	65	250
Flexural strength (MPa)	105	400	320	95	250
Thermal conductivity ($Kcal/hr/m^2/° C$)	0.4	732	1,220	6.4	24.4
Stretch coefficient ($(cm/cm° C) \times 10^{-6}$)	1.7	10	8	37	5.2
Maximum working temperature (° C)	160	600	600	55	130
Fire resistance[1]	low	Very good	Very good	low	good

As we see, FRP is the strongest in terms of density. Despite FRP's expected flex, which is high, in the rest of its structural parameters, it comes closest to steel of all of the materials. In addition, it is particularly fire resistant, in contrast to plastic and wood.

Summary

The corrosive environment of cooling towers requires knowledgeable choices of building materials. FRP in its various versions fills the requirements of corrosion resistance, structural strength, and robustness in a wide range of temperatures; and therefore is the most suitable for use in cooling towers.

[1] Fire resistance depends upon special defined additives in terms of flame spread as per the UL94 standard.

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