Technical Information for GRP

The nature of Reinforced Plastics:
Reinforced Plastic is the generic term used to describe specific plastic materials reinforced with high strength fibers. Since their development, these materials have been commonly known by names such as “Fiberglass” or GRP (Glass Reinforced Polyester). Within the reinforced plastics industry itself, “Composite” is the term felt to best describe this light, durable and astonishingly tough constructional material which can be fabricated into all manner of products. It may be translucent, opaque or colored, flat or shaped, thin or thick. There is virtually no limit to the size of objects which can be made, and single pieces over 60 meters long have already been fabricated as boat hulls.

GRP (Glass Reinforced Polyester) is unique amongst composite materials of construction in that the fabricator actually makes the material. Whether he/she is making roof sheeting, chemical tanks, pipes, silos, buildings, vehicle bodies, or boats he/she is not merely assembling pre-existing components but making the structural material in situ.

What then is GRP?
It is a composite of a resilient durable resin with an immensely strong fibrous glass. The resin is the main component and is normally a polyester resin. It is supplied in the form of viscous syrup, which when suitably activated sets to a hard solid. Buttons and castings are made from such a resin, but just as concrete may be reinforced with steel rods, so polyester resin may be reinforced with glass fibers to form GRP. This is what the fabricator does. He/she uses a single surface mold or form on which he/she impregnates layers of glass mat with liquid resin until he/she has built up the required thickness, so forming a laminate or molding. After removal of this product from the mold he/she can make many more in the same way.

GRP as a Structural Material:
GRP can only be used to the best advantage if the fabricator designs for the material. Able to do this, the designer must take into consideration the mechanical properties of the laminate as well as the methods of fabrication which it is intended to use. The advantage of using GRP over conventional materials is the ability to design and build large structures conceived as a whole and not as an assembly of parts which have to be jointed together. Another advantage of GRP is the possibility of varying the thickness of the material locally and of increasing the strength characteristics at any point in any direction simply by making intelligent use of the glass fiber reinforcement. Each design problem must be approached without thinking of GRP just as a replacement for traditional structural materials.

Building and Construction:
Composites are extremely versatile and have been used in many areas of the building and construction industry for more than thirty years. Modules and cladding are the two most popular ways of using composites in building. Modular composite construction is an extension of long established prefabrication techniques, which utilize to the full the light

weight nature of composite moldings. As they are manufactured in a mold, it is relatively easy to produce large numbers of identical modules in various geometric designs. The ability to be formed into complex shapes, to be textured and to simulate natural materials such as wood, slate, stone etc., are among the reasons for the successful use of composites as external cladding materials. The light weight and excellent strength to weight ratios of composites enable designers to meet specific criteria such as impact resistance, insulation properties and fire resistance. Composite modules and cladding panels are aesthetically pleasing and their strength, durability and weather resistance means they require minimal maintenance compared too many conventional building materials. Resins and gel coats have a proven track record of over thirty years in the building and construction industry. The use of these materials offers Architects, Civil Engineers and other specialists exciting opportunities to provide unique benefits and attractive solutions to building design today and in the future.

The Gel Coat

The durability of a composite molding is mainly dependent on the quality of its exposed surface. Every possible precaution must be taken to prevent fibers from coming too near this surface where they may be liable to attack by moisture. This is achieved by providing a resin rich area on the working surface of the laminate, and this is the **Gel Coat.** In many ways the gel coat is the most important part of the laminate. Gel coats in various colors BS or Ral.

Catalyst:

In order to produce a molding or laminate using a polyester resin, the resin must be cured. This is achieved either by the use of a catalyst and heating or at room temperature by using a catalyst and an accelerator. Most Crystic resins are supplied pre-accelerated, incorporating an accelerator system designed to give the most suitable cure characteristics for the fabricator.

Organic peroxides are normally used as catalysts in the composites industry. Since these materials are unstable in the pure form, they are mixed with an inert compound before being supplied commercially. This process is known as phlegmatisation and is carried out during manufacture. Phlegmatisers are usually liquids (e.g. phthalates) or inert fillings (e.g. chalk) but other media are sometimes used.

The types of catalyst most commonly used, particularly in conjunction with polyester resins, are Methyl Ethyl Ketone Peroxide (MEKP), Cyclohexanone Peroxide (CHP), Acetyl Acetone Peroxide (AAP) and Benzoyl Peroxide (BPO).

Glass Fiber:

Glass is an ideal reinforcing fiber for plastics. It is one of the strongest of materials (the ultimate tensile strength of a freshly drawn single filament of 9 – 15 microns diameter is about 3.5GPa). Its constituents are readily available; it is non-combustible and also chemically resistant. Glass Fiber is produced by drawing and rapidly cooling molten glass and is available in a variety of types and formats. Its final format will depend on how the drawn glass is further processed.

In the composites industry today “E” (Electrical) and “C” (Chemical) are the predominant grades of glass used. Developments in glass fiber technology mean that glass reinforcements are now available in a wide variety of styles and formats, suited to diverse applications in many industrial sectors.

RESINS:
Several resin types are employed in the manufacture of composite products. All of these resins are thermosets but they differ in their chemical make up, thus exhibiting diverse properties. This means that manufacturers can choose resin which enables them to tailor their products to meet specific requirements.

FIRE RETARDANT LAMINATES:
Polyester resins are made up of carbon, hydrogen and oxygen atoms and like all organic compounds, they will burn. However, by altering their structure and/or by the use of additives, it is possible to modify their burning behavior so that laminates made from such resins present a lower hazard under fire conditions. In most applications the use of GRP presents no greater fire hazard than the use of timber. Unfortunately a “standard fire” does not exist and behavior of GRP in a fire depends on a number of factors amongst which are:

- Ease of ignition.
- Surface Spread of flame.
- Fuel Contribution.
- Fire penetration.

FIRE TESTS:
Many tests for fire behavior exist and almost every country has its own particular methods, often requiring large specimens and special equipment.

Polyesters:
Resins are unsaturated polyesters. The raw materials used for the manufacture of unsaturated polyester resins are oil based and to produce polyester of this type, three basic chemical components are generally required.

A: saturated acid (e.g. phthalic anhydride)
B: unsaturated acid (e.g, maleic anhydride)
C: dihydric alcohol (e.g. propylene glycol)

With the application of heat, these chemicals combine to form a resin which is a viscous liquid when hot, but a brittle solid when cold. The term “polyester” is derived from the link between A or B with C, which is termed an “ester” link. Whilst is still hot, the resin is dissolved in a monomer which is usually styrene though others can be, and are, used. The monomer performs the vital function of enabling the resin to cure from a liquid to a solid, by crosslinking the molecular chains of the polyester. No by-products are evolved during this process, which means the resin can be molded without the use of pressure. They are therefore known as contact or low pressure molding resins.

Once the resin is cured, if will continue to mature, during which time the molding will acquire its full properties. This process, which can take several weeks to complete at room temperature, can be accelerated by post curing the molding at elevated temperatures.