Glass-Fibre

Glass-Fibre is really a generic term for a whole range of products which use a glass strand material, either in loose form or cloth, set into a hardened resin material to make a stiff and strong structure.

Originally designed for the building industry glass-fibre was initially developed as an insulator (which it is ideally suited to).
Very fine glass fibres could be spun into a wool like material which was both dense and lightweight. This wool like material was able to retain and withstand huge amounts of heat, without transferring the heat through the material itself.

Within just a few years the manufacturers were able to (probably by accident) use the product as a building material.
Initially setting the glass fibres into concrete to make a lightweight and strong building material which was also "self-insulating".
This then gave rise to the material being composited with polyester resins to make a thin, strong and lightweight construction material for applications as various as sports equipment, car body assemblies and even aeroplane construction.

Within the model making industry it was also found that glass-fibre was ideal for making strong support structures in particular and even in some cases as an actual model making material itself.
Because glass-fibre is not only comparatively cheap, but also very strong, the product very quickly took the place of jute scrimshaw (although jute does still have a place) for larger structures, in combination with plaster and cement.
More common now glass-fibre is associated with polyester resin.

Composite Glass fibre:

A composite is a product formed from two or more components – Glassfibre Re-enforced Plastic (GRP) was one of the first recognised "composite" materials.
The first being the aeronautical Mallite which was plywood and aluminium sheet bonded together – GRP was much lighter and had better all-round strength and durability capabilities as Mallite, but was also cheaper to manufacture.
Later on came Carbon-Fibre, Textron and Kevlar all of them basically a composite made up of a fibre or cloth and a resin.
The term RESIN is applied to any product which is liquid in its natural state and cures to a solid using a curing agent or catalyst.

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The resins used to set the GRP are usually polyester based, but glass-fibre can equally still be set within plaster, concrete, even with flour and water paste – basically anything which will hold the material in suspension and set.
That said there is no guarantee that the set material will be strong of course, this depends on the "resin" material and the "lay up" of the glass fibre itself.

Different types of Glass-Fibre:

Tissue Fibre:
Fine strands of glass fibres rolled into a fine cloth like material.
Ideal for fine complex moulds – these fine fibres don't give a very strong structure.

Chopped Strand:
Literally small pieces of loose glass fibre.
Available in three sizes – coarse, medium and fine.

Chopped Strand Mat (sometimes called matte):
Rolled chopped strand material – the material forms a smooth cloth which can be easily pushed into moulds using brushes and rollers (depending on the mould complexity).

Vitcas Matte – also known as Quadaxial Mat:
Very open weave (similar to jute or scrim in appearance) glass-fibre cloth – used in particular for Jesmonite moulds.

Woven Mat:
Strands of fibres woven into a thick and strong fabric like material.
Usually thicker than chopped strand mat – but much stronger when cured.
Particularly useful for lightweight heavy duty type applications.

Ribbon:
This is basically thin strips of the woven mat.
Ideal for strengthening the join line of complicated castings.

The components of all of the above are basically the same, thin strands of glass spun into a fibre and then woven or rolled into a cloth.
This woven material is by far the strongest – the chopped strand relies purely on the resin for strength. However the ribbon and woven matting has the ability to offer torsional and shear strength to the laminate.

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Resins:

As stated earlier a resin is a liquid which hardens via a catalyst into a hard shell.

Plaster can be used with glass-fibre – it forms a good strong casting especially if you build an initial skin layer, then add glassfibre laminated with additional plaster as a backing to increase the strength of the casting.

Plaster Polymer – an acrylic addition cure that changes the plaster into a thixotropic liquid, used instead of water to make up the plaster mix, it allows the modeller to paint the plaster onto the sides of a mould, ideal for forming skin layers and to pick up fine mould detail.
Often mistaken for another product called Jesmonite.

Acrylic (Jesmonite) resins are becoming ever more popular.
These resins are similar in properties to plaster (water soluble components) but offer similar stiffness to polyester (although for larger moulds Jesmonite can be very heavy and rather brittle – but is both lighter and stronger than plaster).
The chief advantage is the lack of odour (in comparison to polyester at least).

Polyester resin is the most commonly used with glass-fibre – so too is the smell, the "niff" is strongly associated with GRP.
The resin can be used as an outer "gel coat" – it gives a smooth polishable surface and can even be coloured using suitable pigments (you can also use cellulose paint within a gel coat finish).

Epoxy resin can be used with glass fibre (although more typically it is used for carbon fibre) – epoxy reinforced glassfibre composites require vacuum curing though to remove air pockets.

You can pretty much use any adhesive to lay up with glass fibre – some are more suitable than others.
Plaster and Jesmonite are heavier but the most cost effective – polyester is the lightest and most durable, it also suffers less from shrinkage.
For large moulds where you want the components to retain their shape without adding too much weight, then always go for polyester.

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Parting Agent:
Typically a thin coating of wax or silicone applied to the inside of the mould to prevent the glassfibre from bonding to the mould.

Mould Preparation:
Moulds are typically very smooth internally.
This internal structure forms the outer extremity of the glass fibre casting.
It is also common for the mould to also be made from glass fibre – but the INSIDE of the mould is covered with the "gel coat" – this layer has to be kept spotlessly clean and a thin coating of release agent should always be used prior to the lay up.

Gel-Coat Layer:
Most typically a glossy outer shell of a GRP casting around 1-5 mm thick – this is normally made using pure resin (sometimes with colour added), applied in layers to the walls of the mould and allowed to partially cure.
Then layers of glass-fibre are added to the mould with additional resin – these layers bond to the gel-coat to strengthen the whole assembly.

Lay-Up:
This is a term used for the initial application of glassfibre material into a mould, if the mould is designed to be for a finished piece, then it is normal to apply an outer "gel-coat".
Thinner components, or components designed for rough work, the lay-up is done with glass-fibre applied direct to the mould and then resin poured over the fibres and stippled into the mould form.

Hollow Moulds:
Two half moulds can be joined together using a slush mould technique – take the two half moulds at the semi cured state (touch dry) join the two halves and then pour in a quantity of resin, rotating the mould to spread the resin across the join line, you can use long handled rollers to press the resin home across the join and work the resin into the gaps.
Glass-fibre ribbon can be applied to the join line too, this gives additional strength to the finished piece, but this very much depends on access inside the mould to push resin through the ribbon and force it into place.

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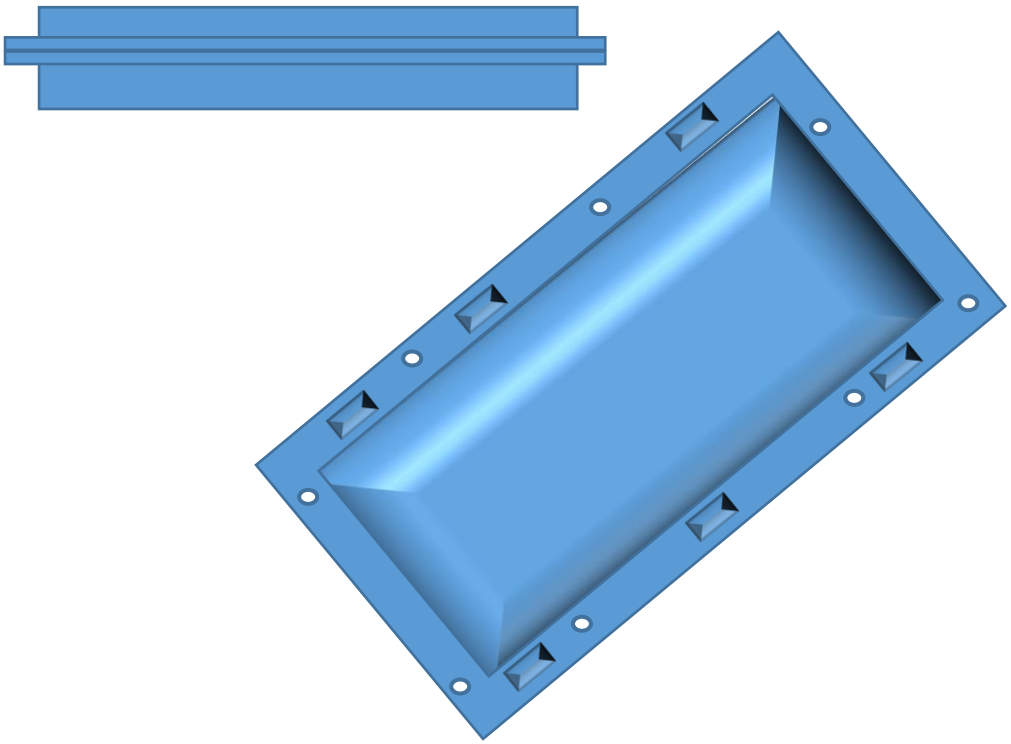
Glass-Fibre Re-enforced Silicone.
Silicone moulds are commonly used for even quite large castings.
Forming a silicone mould around a clay or wood model piece with a thixotropic addition, allows modellers to make a very accurate and smooth mould.
This gives excellent repeatability and quality.
However silicone is not very rugged so to stiffen and support the mould, it has become common to build a support re-enforcement structure around the silicone in plaster or glass-fibre.

This re-enforcing layer prevents the silicone from deforming and prolongs the life of the mould.
More recently Jesmonite has been used as a resin for the glass-fibre, mainly because it is stronger than the more traditional plaster bandage or scrim, but also because Jesmonite is a more pleasant product to work with in comparison to polyester – the product is an acrylic/gypsum based polymer which is water soluble.

It is important with re-enforcing layers that these are accurately positioned by using fencing between the components of a multi part mould.
This used to be done using either thin brass or aluminium sheet.

Either way the horizontal land areas surrounding the mould components should have a number of solid register points cast into them, this is to make sure the mould clips back together accurately.



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This leaves you with a two part mould with an accurate register for assembly – a series of drilled holes allows the mould to be bolted securely together.

The assembly of the mould is best kept as simple as possible.
Multi-piece moulds are ideal for large heavy pieces, this limits the risk of sagging and makes initial skin layers much easier.

Cure Times:

Typically glass-fibre cures within 4-6 hours, the surface of the mould will remain tacky for 3-5 days beyond this and will require polishing to remove this tacky layer.
If the internal suface of the mould is designed to suit a gel coat, this polishing needs to be to a very high lustre.
Gel coats need to be very smooth indeed – any blemishes will be amplified by the gel coat itself.

Finishing:

Again this is a typical operation – remove the components from the mould, taking care to split the mould gently and avoid damage to the casting.
The edges of the casting can be polished and any blemishes filled (using additional mixes of clear or coloured resin) and then sanded back to surface finish.

Repairs:

Glass fibre is not easy to repair – many repairs are not only unsatisfactory but often appalling! It is not enough just to place a bit of ribbon and some resin over a cracked or damaged glass fibre casting.

Cracks in the gel coat layer need particular attention – this is a specialist operation but is possible and with experience the results are invisible.
Drill a hole at each end of the damaged area (this can be 2, 3, 4 or more holes depending on the damage), this prevents cracks extending beyond the damage and into the main body of the casting.
Feed resin (polyester or epoxy is best for this) into the damaged parts and then stipple glass fibre matting into and over the damaged area on both sides.

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When the resin has fully set, sand the area back level with the surrounding casting, then using pigmented resin, infill the damaged area back to the original colour.
If the gel coat layer is painted then you must use etch primer on the whole casting before re-painting.

General glass-fibre repairs can be done using layers of resin and matting, but honestly it is better if you follow the above method here too – otherwise too much additional weight can creep in along with inaccuracies which can influence silicone moulds in particular.

There are glass-fibre repair kits available – these are a pre-mixed paste made up of resin and chopped strand.
An additional hardener has to be added to this mixture and the mixture smoothed over the area to be repaired.
Once cured the repair can be sanded back and the repair will be fairly invisible and very strong – care has to be taken not to alter the structural integrity though.

At Alec Tiranti we are always happy to offer help and advice on projects however large or small, we don't pretend to know everything but, we can often put you in touch with other specialists that can help you.

We have people here at Thatcham and also at our shop in Warren Street who have a wide experience using glass-fibre, resins, plaster and Jesmonite.