

## Hand Laminating

Hand lay up is the most widely used fabrication technique employed in the reinforced plastics industry. It is normally used for relatively short runs, but it has also been adapted successfully for series production. It is a production method which takes full advantage of the two most important characteristics of polyester resin i.e. that it cures without heat and without pressure.

Briefly the mould surface is prepared by polishing to whatever degree of surface finish is required, then a release agent is applied. The next step is to apply a resin rich surface (gelcoat). After this has cured sufficiently, liquid resin is brushed onto the gelcoat surface, glass is placed on top and each layer is then impregnated with resin. The laminate is then allowed to cure at room temperature (at least 15 deg C) and depending on conditions and the type of resin used, the cure time can vary from 1 to 4 hours.

1 The first step is to prepare a suitable mould (see application sheet on Mould Making).

2 Apply a film of wax polish (silicone free) to the mould surface, keeping the quantity to a minimum. This is then polished out with a fine cloth to a high polish. Some types of wax used to be left to harden but all waxes must be used to manufacturers recommendations.

3 A film of poly vinyl alcohol (PVA) solution is applied evenly, by spray or sponge, over the whole mould surface and allowed to dry at room temperature (see application sheet). Because of its low viscosity a PVA solution will drain from vertical sections and accumulate in sharp corners where it may take a long time to dry. If this is not prevented and the moulding is laid up too soon, it will almost certainly stick and some damage may be done to the mould.

4 The durability of a GRP moulding is mainly dependent on the quality of its exposed surface. Every possible precaution must be taken to prevent fibres 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 - the gelcoat (see application sheet on gelcoat).

5 The next step in the process is the lay up of the glassfibre reinforcement with polyester resin. Laying up can be started as soon as the gelcoat has hardened sufficiently to withstand solvent attack from the laminating resin. The simplest way of checking this is to touch the back of the gelcoat lightly with a clean finger. If the gelcoat feels slightly tacky, but the finger comes away perfectly clean, then the gelcoat is just at the right stage for laminating. Sometimes a glass tissue may be laminated next to the gelcoat in anti corrosion applications. This also helps to cut down the risks of the glassfibre pattern showing on the gelcoat surface.

6 Chopped strand glassfibre mat is the most usual reinforcement although woven rovings can be used. Woven rovings however should have at least 2 layers of reinforcement mat between them and the gelcoat otherwise the 'chequered' pattern of the rovings will show through. Woven rovings should not be used adjacent to one another because they have poor inter laminar adhesion.

Consequently at least one layer of reinforcement mat between the layers of woven roving is recommended. The reinforcement should be prepared before laminating begins. It can be cut to size and tailored if necessary with scissors or a sharp trimming knife. The amount of resin required can be calculated by weighing the glassfibre to be used for the mouldings. For chopped strand mat the resin / glass ratio is usually between 3:1 and 2:1 by weight. (25-33% glass by weight).

7 At this stage pigment is added to the resin if desired. A quantity of pigment paste is mixed into the resin, preferably with a mechanical mixer to achieve even dispersion. The majority of resins used these days are pre-accelerated and only require the addition of catalysts (hardener) to activate them before use. The quantity of catalyst required as with the quantity of pigment, will have been obtained from information supplied with the resin, which will give quantity of catalyst for a given working temperature to achieve the desired pot life.

8 A liberal coat of resin is brushed over the gelcoat as evenly as possible and the first layer of glass is pressed firmly into place and consolidated with a brush or roller. The resin will impregnate the glass mat quite readily and dissolve the binder which holds the fibres together. The mat will thus conform readily to the contours of the mould. Unless absolutely necessary no additional resin should be applied on top of the mat until it is fully impregnated because this may lead to air bubbles being trapped. When the laminate contains air bubbles it is milky in colour (this is true only of course if the laminate is made using unpigmented resin). As the air is being released the colour of the laminate will change to the natural colour of the resin. When a brush is used for impregnation it should be worked with a stippling action and not moved sideways across the surface. The normal brushing action will displace the fibres and distribute them unevenly. Consolidation of the laminate is quicker with a roller than a brush. Adjacent pieces of chopped strand mat should be overlapped by tearing at the join rather than cutting.

i) Subsequent layers of resin and glass mat are applied until the required thickness has been built up, taking care that overlaps are staggered to prevent local excessive thickening, causing uneven cure and shrinkage. Each layer must be worked until it is completely impregnated. Where a thick laminate is required no more than four layers of resin and glass mat should be applied without allowing the resin to reach a state of gelation and most of the exotherm to take place. This is to avoid a build up of exotherm which may result in either cracking on the surface gelcoat, pre-release of the moulding due to excess shrinkage or discolouration of the pigmented resin.

ii) During the lay up operation it is possible to incorporate wood and metal strengtheners, also fittings and sandwich materials used such as paper honeycomb, polyurethane foam or balsa wood. Durobond, a specially formulated polyester adhesive can be used for securing fittings and ribs before laminating in place. This lamination should not take place until the main laminate has passed the 'green stage' i.e. cured to a certain degree, otherwise the addition of ribs etc. will cause localised excess shrinkage and on mould release there will be found to be a 'ripple' on the gelcoat opposite the fitting.

9 When a smooth finish is required on the reverse side of the moulding i.e. the working side, a suitable glass tissue can be used as the final layer of reinforcement. This will give a finish which is not as coarse as chopped strand mat and can look attractive when painted.

10 After the resin has gelled it is in a soft rubbery state and green for a limited period. In this condition the laminate can be quickly trimmed by hand with a sharp knife to the dimensions of the mould and suitable trim edges can be built into the mould for this purpose.

11 The moulding is allowed to cure either at normal room temperature (20° C) or in a warm room (30-40°C).

12 After removal from the mould the mouldings should be allowed to mature for a few days or given a post cure, after 24 hours at ambient, at approximately 60-100°C from 1-4 hours dependent on the final environment of the finished moulding. In many cases it is advisable to post cure in a jig to avoid distortion.

13 The poly vinyl alcohol film is finally removed by washing from the surface of the moulding using soapy water.

## **FINISHING**

The fibreglass laminate can be finished off with any paint system after the surface has been sanded. For further particulars see articles on Fairing and Application of coatings on a GRP surface.

## **STIFFENING OF LAMINATE**

The laminate can be stiffened with a 'tophat' or stringer arrangement, this can be done by sticking down a piece of polyurethane or cardboard pipe, etc and laminating over it.

Specialised core materials such as Klegecell and Balsa will create a sandwich panel , which will greatly increase the flexural strength (rigidity) but not add much weight to the overall laminate.  
(See articles on sandwich construction)

#### **CLEANING**

Remember to clean your brushes and equipment after regular intervals. This is normally done with Acetone or Methyl Chloride.

#### **CAUTION**

- 1 If accelerator is used ensure that it does not come into contact with catalyst. The reaction could cause an explosion.
- 2 Catalyst is a hazardous chemical so closely follow the manufacturers recommendations on storage and handling.