17.1 Introduction

In the previous chapter the utilisation of solid wood was described: with the possible exception of preservative treatment where necessary, the wood was used in its original converted and seasoned state, the various parts of the structure being joined together by adhesives, nails or connectors. In this chapter wood is treated as a raw material suitable for further processing, and attention is directed specifically at three very different areas. The first relates to the addition of resins and plastics to the timber which enhance its technical performance without basically modifying its structure: two types of product are discussed below in some detail, the first incorporating phenol formaldehyde resins which set under heat and pressure, and the second using liquid plastic monomers which are polymerised in situ to give a wood-plastic composite.

The second area of interest is the new generation of so-called 'engineered timber' in which pieces of wood are bonded together with an adhesive to produce 'timber' battens.

The third area relates to the cutting-up of wood and its re-formation into board materials, frequently, but not always, with the assistance of a synthetic resin. These products now constitute a third of the UK consumption of timber and timber products, and the five principal board types are discussed in considerable detail.

Wood pulp is a further manufactured wood product, very different in behaviour from both timber and the board materials and, as such, outside the scope of this book.

17.2 Enhancement with plastics

Although the two manufactured products described below embrace the chemical treatment of wood, it is not the intention to describe here the various processes of chemical modification of wood to improve its dimensional stability. Rather the reader is directed to Chapter 9, section 9.6 where this subject has been covered in considerable detail.

17.2.1 Impregnated and compressed wood

A number of 'improved wood' products were developed in the 1940s and 1950s, much of the impetus for this development occurring during the second world war as a result of either the need for specialist materials with good dielectric properties or non-magnetic characteristics, or as a straight replacement for certain metals which were in short supply.

Most of these improved woods were, and still are, produced from hardwood veneers bonded together using phenol formaldehyde resins at high temperature and pressure: this results in transverse compression of the wood and increased density. There are two principal types of product: the first uses dry but otherwise untreated veneers which are bonded together, generally using a dry film of phenol formaldehyde, to produce a densified laminate or 'super-plywood' which is sold in the UK under the trade name of 'Permawood' (see below).
The second variant of the process is to impregnate the veneers, generally under vacuum, with a solution of phenol formaldehyde prior to their assembly and pressing. Adhesive loadings as high as 50 per cent can be achieved, though generally from 20 to 30 per cent are used: a whole range of these impregnated, densified laminates have been produced in both the UK, such as 'Jigwood', 'Jablo' and 'Permali', and in the USA, such as 'Compreg'.

Although extensively used during the second world war period, especially in the production of aircraft propeller blades, demands for these improved wood products decreased markedly in the 1950s with the introduction of the synthetic polymers. However, both 'Permali' and 'Permawood' are still produced in the UK, albeit for only a few very specialised uses. Both products can be tailor made to suit necessary requirements by varying the arrangement of the wood veneers to give maximum mechanical strength in any particular direction.

Permali, the veneers of which are impregnated under vacuum before being densified under heat and pressure, has a density of about 1200 kg/m$^3$ and very good dimensional stability in the presence of moisture: compression strengths, hardness and abrasion resistance are exceptionally high, though its bending strength is only marginally better than timber of the same density. The strength-to-weight ratio of Permali is usually considerably higher than that of steel.

It has excellent dielectric properties and its principal application nowadays is in the production of electrical insulating components which are subjected to severe mechanical forces: it is available in the form of sheets, rings and rods.

Permawood, assembled from veneers which have not been impregnated with resin, though still bonded together under pressure and heat, has a slightly lower density of 900–1200 kg/m$^3$ depending on grade. The higher density material is sometimes called 'Hydulignum'. Dimensional stability and dielectric properties are again high and the product is used primarily in the production of certain types of large transformers.

### 17.2.2 Wood–plastic composite

Brief mention was made in Chapter 9, section 9.6 concerning the impregnation of permeable woods with liquid monomers which were then polymerised in situ to form a composite material with greatly improved dimensional stability and a marked enhancement of certain strength properties. The monomers most frequently used are monomethyl methacrylate or a mixture of styrene and acrylonitrile: polymerisation is induced by the use of either gamma irradiation or by heat in the presence of a catalyst. Swelling of the timber occurs during impregnation of the polymer, thereby indicating penetration of the cell wall, as well as coating and sometimes filling the cell cavity. The degree of swelling of treated wood in the presence of moisture is reduced to about 10 per cent that of matched untreated samples: additionally, certain strength properties, such as hardness and abrasion resistance, are from two to five times greater for the treated than the untreated wood. Many of the strength properties show little change, while the modulus of elasticity and impact resistance are usually reduced.

Following a long period of laboratory experimentation at the former Princes Risborough Laboratory, the method was taken up and developed on a small commercial scale by the Applied Radiation Chemistry Group at Harwell. The material is sold under the name of 'Curifax', though it is more frequently referred to simply as WPC (wood–plastic composite). Curifax can be produced in lengths up to 3.66 m (12 feet) but because the cost is about four times that of untreated timber, its use has been limited to the production of specialised items such as cutlery handles, brush handles and decorative flooring; there is considerable potential for its use in turnery and sports goods. An example of the wood block flooring is to be seen in the terminal building of Helsinki airport.

### 17.3 ‘Engineered structural timber’

Several products have been developed over the last decade to produce a superior grade of