

Materials

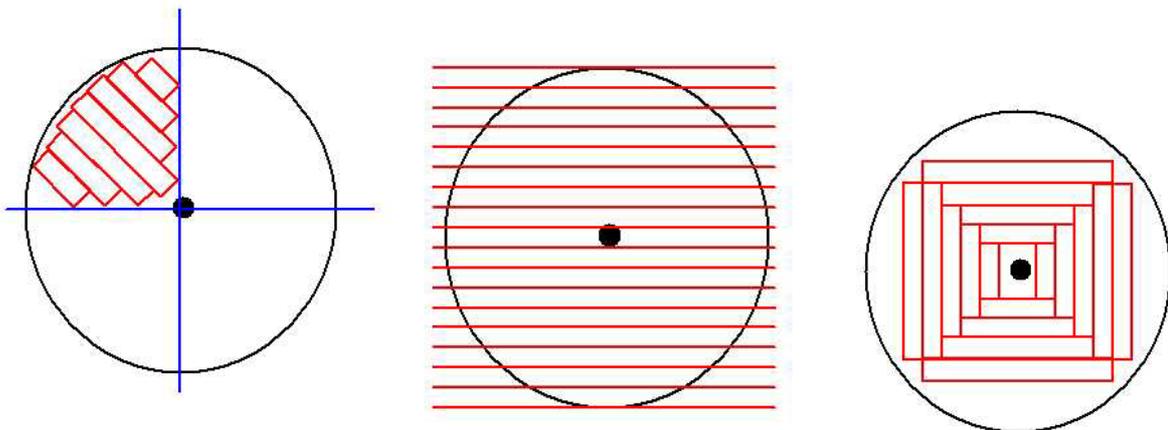
Wood

Introduction

Wood is commonly referred to as a composite due to its cellulose and fibrous structure. Woods are low-density materials that provide structural support in bulk form and barrier properties in sheet form. There are two groups of wood types: softwood and hardwood. In general, softwoods retain their leaves throughout the year and hardwoods lose their leaves each year, though there are exceptions to this rule. Hardwoods are normally hard and softwoods are normally soft, but again exceptions to this rule can be found.

The structure of a tree trunk varies depending on the distance from the centre. From the outermost edge of the trunk, the outer bark provides protection, the inner bark carries food, the cambium is the part that forms new wood, the sapwood is the new growth wood that stores the food and transports sap, the heartwood is the inner part of the tree that provides strength, and the pith is at the centre of the tree.

Woods are regularly selected on an aesthetic basis to show their grain and colouring. The mechanical properties of wood are highly dependant on the direction of the grain and the method of sawing used. The three commonly used methods of sawing timber planks from the tree trunk are plain-sawn, quarter-sawn and tangential-sawn.



Quarter-sawn timber has growth rings that are roughly perpendicular to the longest surface and parallel to each other, this provides timber planks that are stable to changes in humidity and the amount of twist experienced is low.

The majority of the plain-sawn timber has growth rings that are parallel or at an angle to the longest surface. This produces a plank that is susceptible to changes in humidity, that will change section shape if not dried out properly. The plank that is cut through the centre of the tree has growth rings arranged similar to quarter-sawn timber.

Tangential sawn wood, when dried properly, provides higher strength timber suitable for structural elements such as joists and beams.

Whilst the quarter-sawn method provides a higher quality of timber, the amount of waste wood that is produced is greater and the requirement for additional handling adds further cost. The tangentially-sawn method also requires additional handling.

Strength of wood is difficult to predict due to the grain and knot structure, and the presence of minor defects in the timber. Structural timber is graded for its strength properties within guidelines set down in BS EN 338 Structural Timber – Strength Classes.

Wood is supplied in a number of different forms, which can vary from rough sawn timber through planed timber, veneer and fabricated board (or wood-based composite panel) to wood pulp. Some of the different fabricated board forms available are plywood, blockboard, hardboard, MDF (Medium Density Fibreboard), OSB (Oriented Strand Board) and chipboard.

Wood pulp is used to make paper and is available in two main forms, mechanical and chemically generated. The mechanical technique grinds the wood to break the fibres down into shorter lengths, which produces pulp suitable for manufacturing paper with short life requirements, for example newspaper. The chemical technique produces paper suitable for longer-term applications such as books and office paper. The longer life is achieved by removing the majority of the lignin, which reduces the rate of paper decomposition.

Common Softwoods

Pine

There are many different types of pine with different properties depending on where it is grown. Generalised properties of pine are: light brown heartwood, exposure to air and UV light tends to darken surface of the timber, low to medium density, moderate grain structure, moderate strength and stiffness, and easy to work. Applications of pines are usually furniture and construction products. External products require treatment. Yellow pine is soft and easily worked, qualities which are exploited in the manufacture of mould patterns and models.

Douglas Fir

Reddish brown or yellowish brown heartwood. Used in interior and exterior joinery. High-density woods are used for structural members. Widely used in the construction industry.

White Cedar

Light yellow to pale brown heartwood, narrow sapwood. Fine texture and straight grain, low density with moderate stiffness, strength and hardness. Provides good dimensional stability. Applications include window frames and furniture.

Red Cedar

Heartwood varies from bright reds to dull brown, off-white sapwood. Low strength, moderate shock resistance and hardness. Used extensively for fencing posts and panels. Heartwood has a good resistance to decay and is used for marine applications.

Redwood

Heartwood varies from light red to dark brown, off-white sapwood. Provides moderate strength, stiffness and hardness. Good dimensional stability and fairly easy to work. It has good resistance to decay and is used for external building structures.

Spruce

Low strength, stiffness and hardness. Close-grained spruce is used as soundboards in musical instruments with high stiffness to mass ratios to provide the best use of the vibrating string energy. Also used for pulp and papermaking.

Common Hardwoods

Ash

Red heartwood, off-white sapwood. High strength, rigid, good shock resistance, fine grain. Used for the manufacture of frameworks and furniture.

Balsa

White and yellow colouring, very low density and very soft, extremely porous, provides good insulating properties against heat and sound. Used for low strength requirement products including models.

Beech

Reddish brown heartwood, nearly white sapwood. Hard and strong, resistant to shock, fine texture, suitable for steam bending and easily machined. Used extensively for furniture.

Elm

Reddish brown heartwood, nearly white sapwood. Different varieties available, from soft to hard, providing different densities and strengths. Hard elm is used for higher strength applications and soft elm is used for decorative purposes and furniture.

Greenheart

Light to very dark green heartwood. Fine, very dense and uniform grain. Provides good strength, stiffness and wear properties. Resistant to fungal attack, termites and marine life. Used for applications in dockyards that are in contact with water.

Mahogany

Pale pink to reddish brown heartwood. Wide range of grain structures are available, between fine and course. Limited shrinkage during drying and provides good dimensional stability. Can provide fine finishes which can be polished. Used for quality furniture production and decorative products.

Oak

Many different species available. Yellowish brown heartwood. Properties of oak include good strength, moderate hardness and excellent weather resistance and durability of the heartwood. Used for internal and external furniture, joinery, flooring and fencing. Also used widely in the boat building industry.

Sycamore

Reddish brown heartwood, lighter colour sapwood. Exhibits moderate strength, stiffness and wear resistance properties. Can be shaped using steam bending. Used for low specification applications, for example handles, furniture, and small boxes.

Teak

Yellow to golden brown heartwood. Exposure to air turns surface to deep brown colour. Dimensionally stable, moderate strength and stiffness, can be worked by hand easily. Resistant to acids and has an oily texture. Limited availability ensures high price and use in a low number of applications.

Walnut

Light to dark brown heartwood, off-white sapwood. Distinctive grain used for decorative purposes. High density and straight grain provides good strength, stiffness and hardness properties.

Willow

Many different types. Reddish brown to grayish brown heartwood, light tan sapwood. Soft and flexible, providing good shock resistance. Uniform texture with interlocked grain.

Used for weaving of fence panels, garden architecture and baskets. Special cricket bat willow (*Salix Alba Caerulea*) is grown in England and is used because of its even density and grain properties throughout the material.

Internet Resources

The [Institute of Wood Science](#) (IWSc) acts to further an improved awareness wood-based materials and manufacturing processes.

The [Timber Trade Federation](#) promotes the use of timber and aims to provide a prosperous timber market place.

[TRADA](#) provides independent Timber Research, Consultancy and Information for the construction industry.

The [Scottish Institute For Wood Technology](#) conducts research and consultancy activities to enhance the performance of wood based products. It is based at the University of Abertay, Dundee.