ENGINEERING

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ENGINEERING MATERIALS

METALS- PLASTICS -STRUCTURAL WOODS

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ENGINEERING MATERIALS

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FERROUS AND NON-FERROUS METALS

Non-ferrous metals do not contain IRON

Ferrous metals contain IRON

These are metals that contain iron. Consequently they tend to rust / suffer from corrosion. They need protecting with paint, oil or a surface finish. They react to a magnet.

Non-ferrous metals do not contain iron.

Consequently, they do not to rust or suffer unduly from contact with moisture. They do not react to a magnet.

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FERROUS METALS - IRON

Wrought Iron was used by the Romans. Roman iron weapons were forged, not cast. Iron was forged by heating it to high temperatures (to red heat) and hammering it into shape.

Britain had numerous Roman iron ore mines. It also had large forests, which provided the wood required for smelting (extracting the iron form the ore).

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FERROUS METALS – IRON – INDUSTRIAL REVOLUTION

Abraham Darby 1st (1678 –1717)

Developed a technique of producing 'pig iron' in large quantities, through casting molten iron, crucial to the industrial revolution. He developed sand casting techniques, making it possible to produce cast products of a high standard.

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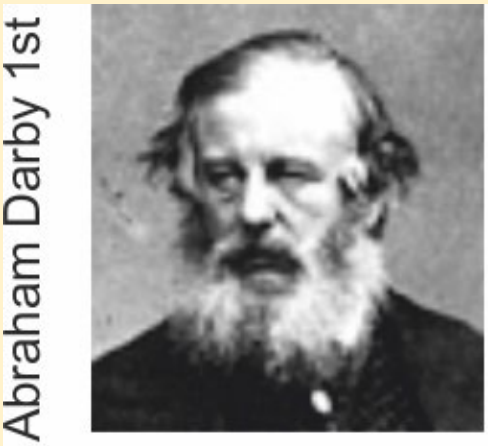

Abraham Darby 1st

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FERROUS METALS – PROPERTIES OF IRON

Cast iron has a carbon content higher than 2.1%. Cast iron is brittle and can snap. Cast iron is likely to break/shatter if dropped or when it receives a 'blow'.

Products include; cast iron garden furniture, house numbers, weathervanes and vices.

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METALS- WHAT IS AN ALLOY?

An alloy is a metal (parent metal) combined with other substances (alloying agents), resulting in superior properties such as; strength, hardness, durability, ductility, tensile strength and toughness.

The parent metal is the majority of the alloy. For example, mild steel is 0.1 - 0.3% Carbon and 99.9 - 99.7% Iron.

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FERROUS METALS
THE ALLOY STEEL

Iron is the most used metal in the world, largely due to it being the main constituent of the alloy steel.

Common steel typically has 0.2 to 2.1% carbon content, with the rest being iron.

Our modern world relies on steel

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FERROUS METALS - MILD STEEL

Carbon 0.1 - 0.3%
Iron 99.9 - 99.7%

Alloy of carbon and iron. Tough. High tensile strength. Can be case hardened. Rusts very easily, unless the surface is protected from moisture.

Most common metal used in school workshops. Used in general metal products and engineering.

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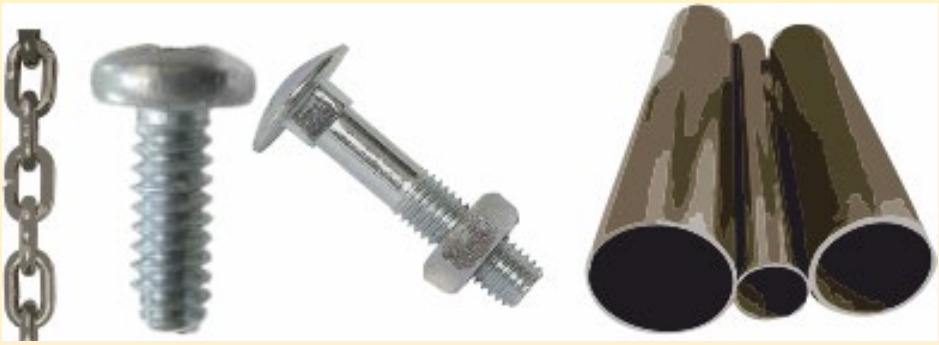

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FERROUS METALS - CARBON STEEL

Carbon 0.6 - 1.4%
Iron 99.4 - 98.6%

Alloy of iron and carbon. Higher carbon content than mild steel. Tough and strong. Carbon steel can be heat treated e.g. hardening and tempering.

Used for cutting tools such as drills and lathe tools.

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FERROUS METALS
STAINLESS STEEL

Alloy of iron, nickel and 10.5% to 11% chromium.

Tough, resistant to rust and stains. Does not corrode.

Cutlery, medical instruments, specialist corrosion resistant products such as pipes. Stainless steel pots and bans. Jewellery and watches.

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ALLOYS

Tap on the green link button for detailed information and an exercise on alloys

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NON-FERROUS METALS
ALUMINIUM

Light grey in colour. Smelted from bauxite ore. Aluminium 95%, Copper 4%, Manganese 1% Ductile, soft, malleable, machines well on lathes and milling machines. Very light and resists corrosion. Can be cast into products from ingots.
Used widely in aircraft, drinks cans, window frames, ladders, and kitchen ware.

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NON-FERROUS METALS
COPPER

Reddish brown in colour, darkens slowly when in contact with air. This metal is not an alloy.

Ductile, can be beaten into shape as it is relatively soft. Conducts electricity and heat. Electrical wiring, tubing, kettles, bowls, pipes and plumbing. Used also in the production of printed circuit boards.

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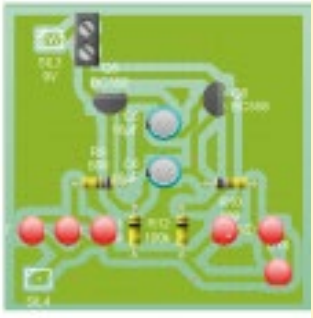

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NON-FERROUS METALS
BRASS

A copper alloy. Deep yellow to golden colour. An alloy, mixture of copper and zinc 65% - 35%.

Casts and machines well. Surface tarnishes slowly on contact with air. Conducts electricity. Resists corrosion.
Parts for electrical fittings, engineering, ornaments, musical instruments.

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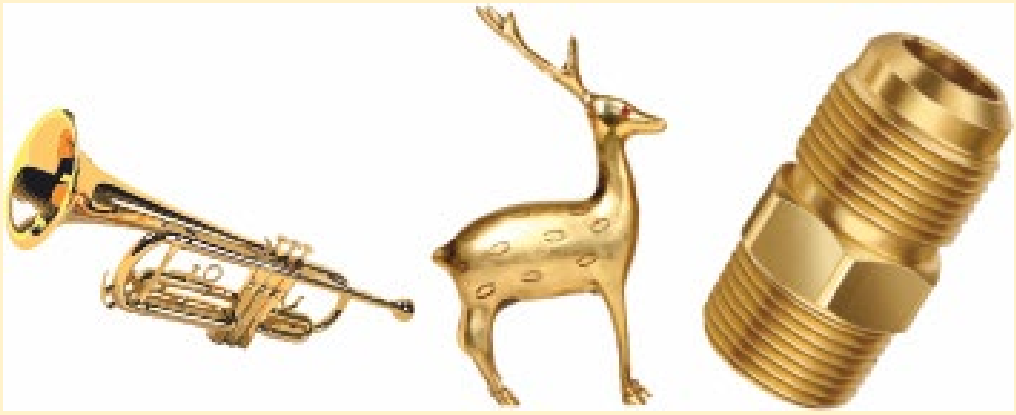

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NON-FERROUS METALS
BRONZE

A copper / tin alloy. Tin content up to 10%. Engineers well on lathes and works quite well with hand tools.

Once used for ship fittings, due to its resistance to corrosion. Now replaced by stainless steel. Used for ornaments, cast bronze sculptures and ships propellers. Used also for bearings in engineering.

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NON-FERROUS METALS
PEWTER

Pewter is a soft, malleable alloy, 85% to 99% tin. Other metals are copper, lead, antimony and bismuth. Has a low melting point compared to many metals (170–230 °C) making it highly suitable for casting.

Usually purchased in ingots and cast to shape in a workshop.
Used for making tankards and other decorative pieces.

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WHAT ARE MANMADE BOARDS

Manmade boards are commonly used in the construction industry, for interior fittings and furniture. They are more stable than natural woods and are less likely to warp and twist out of shape.

The three main types are; plywoods (laminated boards), particle boards and fibreboards.

They are all manmade in factories / mills.

They are usually composed of natural woods and resin, which binds them together.

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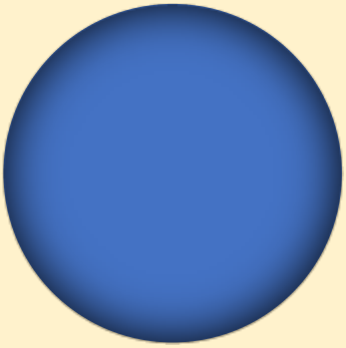

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PLYWOOD - 1

Plywood is a composite material. Composed of individual plies / veneers of wood. The plies are glued together with synthetic resin.

Plywood is less likely to warp or split, due to this construction. Supplied in a range of sizes and thicknesses.

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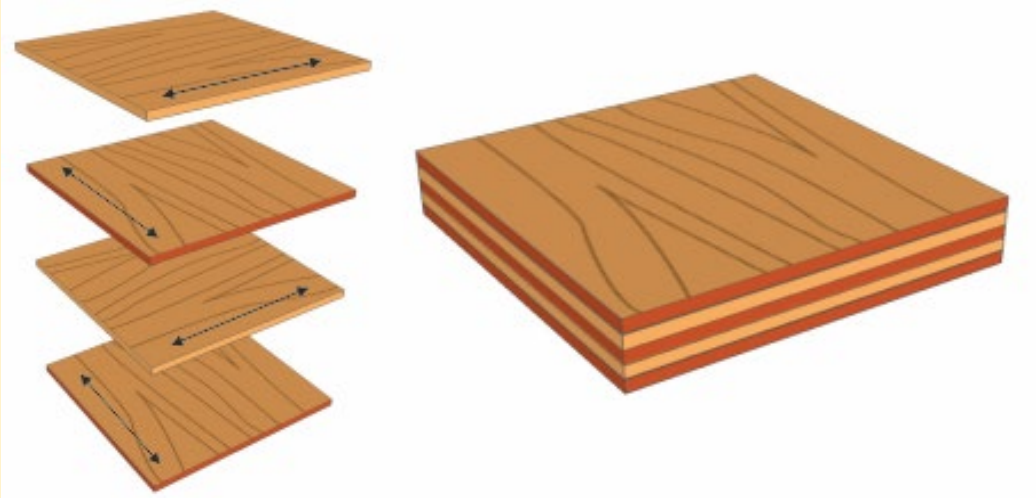

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PLYWOOD - 2

Softwood ply tends to be used in the construction industry for walls, roofs and floors.

Hardwood ply often used for quality laminate flooring, kitchen units and some furniture.

Marine plywood is used in boat hull construction. It is specially treated so that it is water resistant .
Manmade boards such as plywood, can be manufactured so that they are extremely wide. This makes plywood a popular material in the construction industry.

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BLOCKBOARD

A type of plywood. Built up with a core of softwood strips bonded together with adhesive and covered with a sheet of plywood on either side.

Used as a building material and for furniture manufacture including fitted kitchens / bedrooms.

A strong and heavy board, unlikely to warp and twist. The plywood faces are normally beech or other natural woods.

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FLEXI PLY

A flexible form of plywood. Can be formed into various ‘curved shapes.
Composed of several layers of thin plies.
Flexi Ply is ideal for all applications which require bends and curves. This allows the flexi ply to be manipulated into curved shapes.

Available in a range of thicknesses.
Used in modern furniture and interior design where curved surfaces are required.

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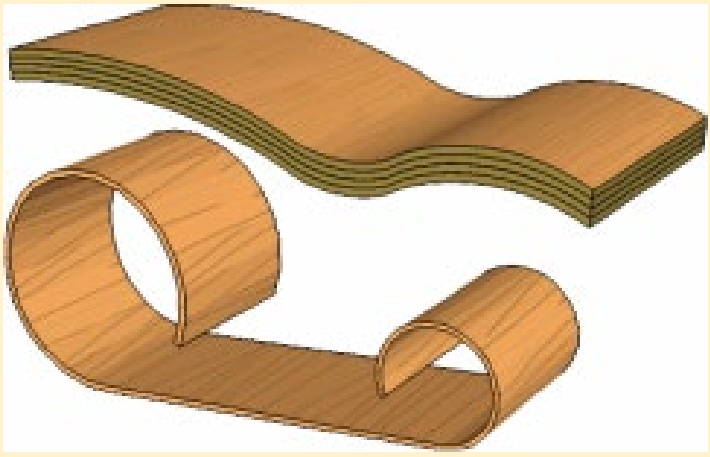

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CHIPBOARD

This is made up of small chips of wood bonded together with resin and formed into sheets by compression.

It is not as strong as plywood or block board, but it is not expensive. Chipboard is often covered with a plastic laminate or wood veneer and used in cheap furniture.
A particle board. Interior and moisture resistant chipboards are available.

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MEDIUM DENSITY FIBRE BOARD (MDF)

A quality board, relatively cheap. Composed of fine wood dust and resin pressed into a board.

Can be worked, shaped and machined easily. Paint can be applied to it, without the need for an undercoat or primer (although finishes better with an MDF primer). Used widely in the building, shop fitting and furniture trades.

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HARDBOARD

Made from wood fibres that have been pulped.
The pulp is put under pressure until the fibres bond to produce a tough board.
Standard hardboard is smooth on one side and rough on the other. It is not as strong as the other boards.
Duo faced hardboard has two smooth faces.
Used for hidden parts of furniture such as the back of a cupboard.

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WHAT ARE THERMOSETTING PLASTICS ?

Once heated and moulded, these plastics cannot be reheated and remoulded. The molecules of these plastics are cross linked in three dimensions and this is why they cannot be reshaped or recycled. The bond between the molecules is very strong.

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THERMOSETTING PLASTICS 1

Many adhesives (glues) are thermosetting plastics. For example, Araldite. Composed of two tubes (one is resin, the other a catalyst). They are mixed to form the glue.

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THERMOSETTING PLASTICS 2

Polyurethane. This forms the basis of many paints and varnishes. Tough, water resistant.

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THERMOSETTING PLASTICS 3

Melamine Formaldehyde. Because of its smooth surface and hygienic qualities, used for kitchen laminates surfaces. Also used for electrical plugs and sockets, because it can be cast and it is an excellent insulator.

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THERMOSETTING PLASTICS 4

Urea Formaldehyde has physical properties of high hardness and high toughness, making it suitable for strong, knock-resistant electrical fittings. It is also scratch resistant and a very good electrical insulator. Electrical fittings manufactured from this polymer are safe to use.

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THERMOSETTING PLASTICS 5

Polyester resins. If resins are combined with a material such as fibre glass, the result is a very tough material that can resist impact. Known as Glass Reinforced Plastic (GRP) and is used in car body repairs, sailing boats and corrugated sheet, because of its lightness, toughness and resistance to water.

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THE DIFFERENCE BETWEEN THERMOSETTING PLASTICS AND THERMOPLASTICS

Thermosetting plastics once heated and formed to a shape, cannot be reheated and reformed. Consequently, they tend to be difficult to recycle.

Thermoplastics once heated and formed to a shape, can be reheated and reshaped. Every time they are reshaped, the quality of the thermoplastic tends to be reduced. They are recyclable.

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WHAT ARE THERMOPLASTICS ?

These plastics can be re-heated and re-shaped in various ways. They become mouldable after reheating as they do not undergo significant chemical change. Reheating and shaping can be repeated. The bond between the molecules is weak and becomes weaker when reheated, allowing reshaping. These types of plastics can be recycled.

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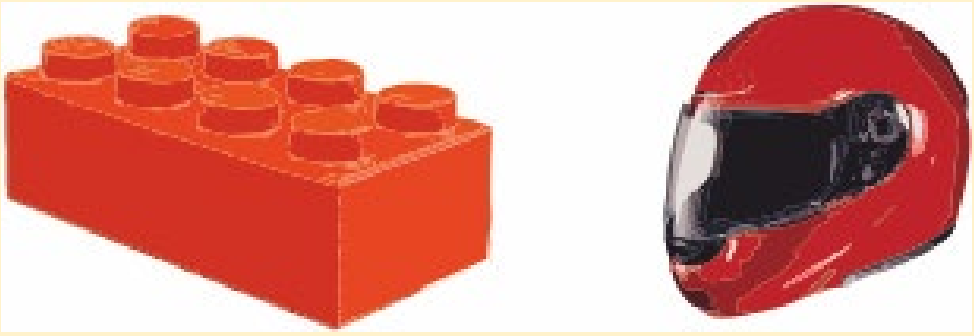

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THERMOPLASTICS 1

Acrylic. (Known also as PERSPEX) This is the most common plastic in a school workshop. Purchased in the form of sheets and comes in a range of colours. It can be translucent (e.g. smoked), transparent or opaque. It is resistant to most acids and weather conditions. Easy to cut shape. Polishes well.
Please note, the brand name Perspex®, is owned by Lucite International (http://perspex.com/).

Baths, safety glasses, signs.

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THERMOPLASTICS 2

LDPE - Low Density Polythene is tough and flexible. Softer than HDPE.

Can be moulded into almost any form. Flexible, comes in range of colours. Bottles and plastic bags are made from the low density polystyrene.

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THERMOPLASTICS 3

HDPE - High Density Polythene which is rigid and hard. Less flexible than LDPE.

Machine parts, bowls and crates are generally made from high density polystyrene.

Can be moulded into almost any form. Flexible, comes in range of colours.

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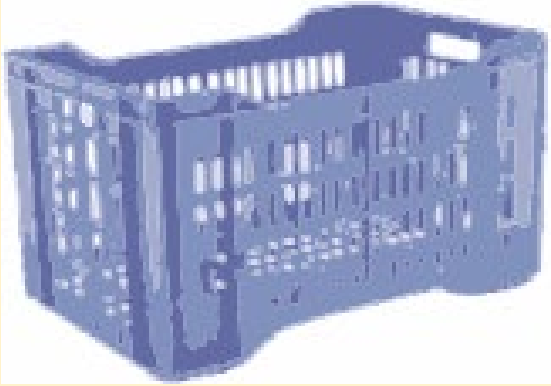

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THERMOPLASTICS 4

Polypropylene (PP) is a thermoplastic often formed into products through injection and blow moulding.
It is robust, strong, flexible and supplied in a range of colours.
Food containers, chairs, packaging and storage units.

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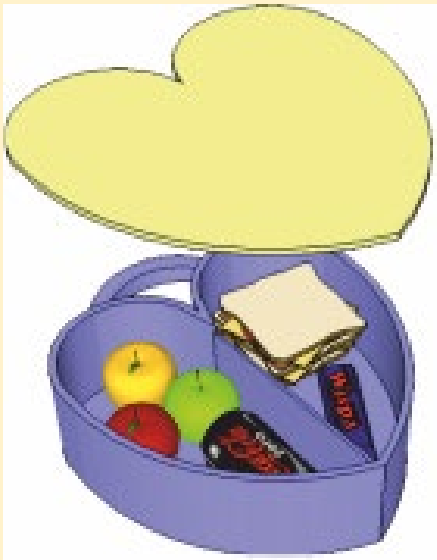

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THERMOPLASTICS 5

Polyvinyl Chloride. Better known as PVC. A tough material, purchased as either a hard (inflexible) material or alternatively a flexible form. It can be extruded, welded or bonded with an adhesive. Range of uses including water pipes, raincoats, long play records, coating on electrical wires and packaging.

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THERMOPLASTICS 6

Nylon. Is used in engineering to make gears and bearings. It's oily nature means that friction is reduced between moving parts made from nylon.

Gears, bearings, wheels and clothing.

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THERMOPLASTICS 7

High Impact Polystyrene (HIPS).
Light material and yet strong. Available in a range of colours. Can be vacuum formed. Thinner HIPS is quite flexible.

Used for electrical casings, packaging, trays

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STRUCTURAL TIMBERS

Structural timbers are considered as an engineering material. They tend to be softwoods, from coniferous trees.

Softwoods are from trees that have needles / exposed seeds, not leaves. They grow quickly, compared to most hardwoods. When sawn and planed they tend to be light/pale in colour. Softwoods also tend to be cheaper than hardwoods.

Softwoods are used by the construction industry to build structures and frames, often used in buildings.

Tap the image
for natural woods
in detail

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PARANA PINE

Virtually knot free with straight grain, making it ideal for a range of uses. Light brown. Very easy to cut and shape, meaning accurate work is easier to achieve than with most softwoods and hardwoods. A smooth finish can be achieved.

Used in the manufacture of furniture. Often used for turning wood products. Used to manufacture plywood.
Plywood is a structural material, used in the construction industry.

Tap the image
for natural woods
in detail

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SCOTS PINE

Sometimes called Red Deal. A popular natural wood. Can be resinous and have plenty of knots. Coloured from light yellow to dark brown. Can be shaped and formed reasonably easily by handtools and machines.

Often used for furniture and the construction industry. Used for interior work. One of the most commonly used woods.

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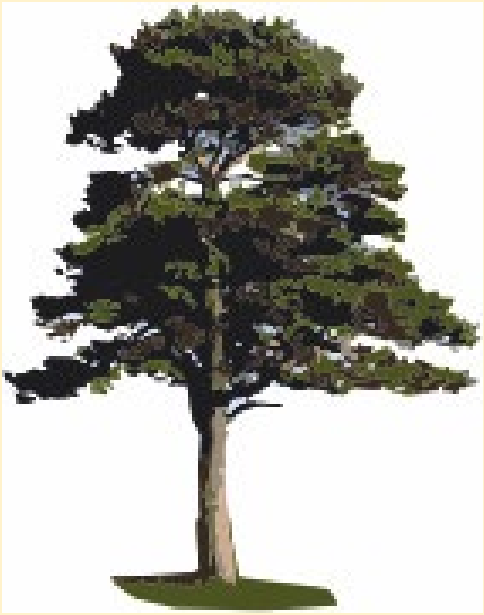
for natural woods
in detail



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RED CEDAR

Has a pleasant aroma, when cut and machined. Its straight grain means that it works well with tools and machines. Starts as reddish brown in colour, after weathering turns to a silver grey.

Used for decking, furniture and general construction. Used for roof shingles, due to its resistance to all weathers.

Tap the image
for natural woods
in detail

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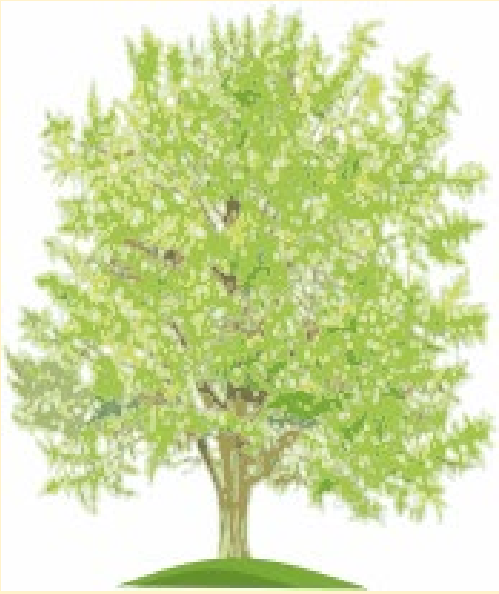
YEW

Straight grained which means it can be shaped and formed quite easily. However, the grain can sometimes be difficult to work. An oily wood that resists natural degradation from the weather and elements.

Used to manufacture both interior and exterior furniture e.g. chairs, gate posts and wood turning.

Tap the image for natural woods in detail



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DOUGLAS FIR

A reddish-brown wood and relatively knot free. Good to work with handtools and machinery. When smoothed to a fine finish, the grain tends to standout from the surface.

Used extensively in the construction industry and in the production of plywood. Also used in a range of joinery work.

Tap the image
for natural woods
in detail

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SEQUOIA

A reddish to brown wood with a texture that varies from smooth to coarse. Can be worked quite easily with hand tools and machines. Glass paper produces a good, smooth finish.

Used regularly as roof shingles, due to its resistance to the weather.
Used for interior and exterior joinery.

Tap the image
for natural woods
in detail

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LARCH

High in resin and straight grained. Pale red to brick red. Can be worked reasonably well with handtools, if knots are avoided.

It is a tough softwood and has a range of uses including; boat planking, window frames, floors and staircases.

Tap the image
for natural woods
in detail

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