Other Materials used in Woodwork

Properties of Materials

These should all be considered when choosing a material to use for a construction or fabrication.

- Physical Properties
  - Dimension or size
  - Density – described as the mass per unit volume of a material. The higher the density the heavier a material generally is
  - Porosity – is the volume of voids or pores in a material
- Chemical Properties
  - Resistance to corrosion
  - Acidity
- Mechanical Properties
  - Strength (tension, compression, shear, etc) – the ability of a material or structure to withstand stress without failure
  - Stiffness – the ability of a material to resist deformation under load
  - Toughness – the ability of a material to absorb energy when being deformed and thus resist deformation and failure
  - Elasticity – being able to return to original dimensions after being subjected to stress that has caused deformation
  - Plasticity – undergoing permanent deformation after being subjected to stress that has not caused failure
  - Ductility – the ability of a material to be deformed by tensile stresses
  - Malleability – the ability of a material to be deformed by compressive stresses
  - Brittleness – having failure occur without much plastic deformation
  - Hardness – being able to resist scratching, abrasion, indentation or penetration
  - Wear resistance
- Thermal Properties
  - Expansion – how much a material changes dimension when subjected to changes in temperature
  - Conductivity

- Electrical and Magnetic Properties

    - Conductivity
    - Magnetic permeability
- Acoustical Properties
    - Sound transmission
    - Sound Reflection
- Optical Properties
    - Colour
    - Light transmission
    - Light reflection

Metals

Metals can be broken into two groups, Ferrous or Non-Ferrous. Ferrous metals are based on Iron (Fe), non-ferrous metals aren't.

Some common ferrous metals include all of the various types of steel and cast iron. An uncommon ferrous metal (depending on its composition) is Nimonic or Inconel. This is a very high nickel content steel alloy, almost to the point where it could be considered nickel based and therefore a non-ferrous metal. Common non-ferrous metals include copper alloys of brass and bronze, and aluminium. Some of the more exotic non-ferrous metals include titanium, magnesium and beryllium.

Ferrous Metals

Steels are available in two main groups, Plain Carbon Steels and Alloy Steels. From these two groups a huge variety of steels can be found. The type of steel is distinguished by its carbon content or alloying elements.

Plain Carbon Steels

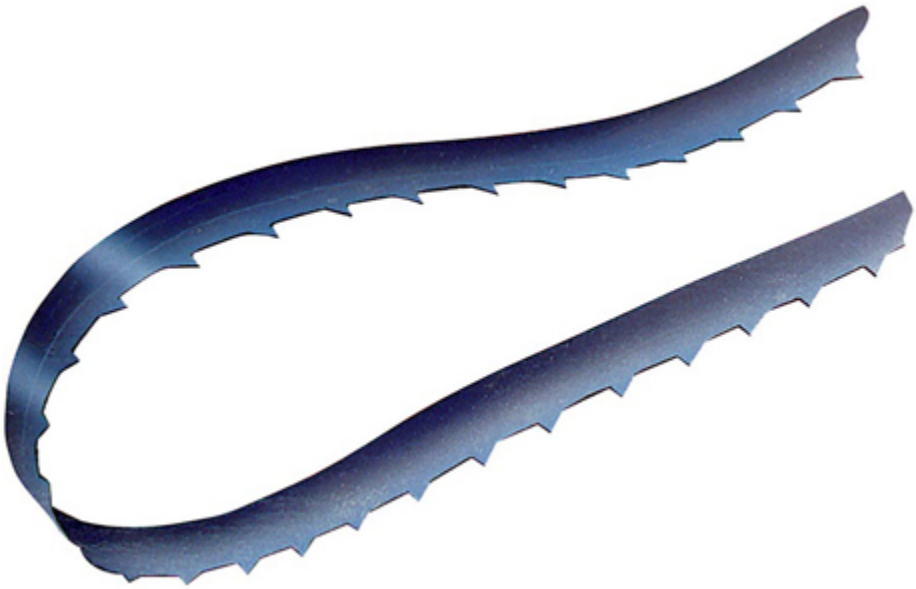
Mild Steel – 0.1 – 0.3% C
High Carbon Steel – 0.6 – 0.8% C
Tool Steel – 0.9 – 1.4% C

Alloy Steels

Stainless Steel – 0.05 – 0.4% C, 8 – 30% Cr
HSS – 0.9 – 1.4% C, 18% W, 4% Cr, 1% V

Mild steel is an extremely common type of steel. Almost all of the steel used in school is mild steel. This is available as black steel or bright steel. It can have a variety of surface finishes applied to it such as chrome plating, nickel plating, paint, polishing, galvanisation, etc. Mild steel has sufficient strength

for most wood working applications and it is inexpensive compared to the other steels. It is very easy to machine and welds well using standard methods such as electric arc and MIG welding.



High Carbon steel is used for bandsaw blades, cold chisels and punches, among other things.

Tool Steel is commonly used for plane blades, chisels, hand saw blades and applications where high strength and resistance to wear are essential.

Stainless steel is well known for its ability to resist rust. It gets this property from the addition of Cr. Stainless steel is harder and stronger than mild steel.

High Speed Steel (HSS) is used for circular saw blades and other high temperature, high-speed applications. Most circular saw blades have Tungsten Carbide Tips (TCT). These TCT are made by using tungsten held together in a cobalt matrix, like an adhesive. This is then brazed onto the blade and sharpened.

Most steels will rust. This means that a chemical reaction occurs where parts of the steel change to Fe(OH)2 (ferrous hydroxide). This is the soft brown/red rust that you can see. From this stage it will

oxidise and become 4Fe(OH)3 (ferric hydroxide). This is the hard rust that everyone hates because it is difficult to remove and usually causes pitting of the base metal.

Nimonic or Inconel is a steel alloy with a very high nickel content. Sometimes this nickel content can exceed 50% and it becomes a non-ferrous metal. This is largely used in the aerospace industry in applications where HSS cannot meet the requirements. It is sometimes lumped in with a group called Super Steels.

Cast iron contains between 2 – 5% C. There are a number of different types of cast iron, all of which exhibit different properties. They are generally very heavy and can be used for large and small products. They can be machined but some are very hard on tools, especially white cast iron.

Non-Ferrous Metals

Brass is an alloy of Cu and Zn. The most common types of brasses are Cartridge Brass and Muntz Metal. Cartridge brass is a 70/30 alloy that gained its name from its wide use in the production of bullet shells. It can be easily cold worked when it is in an annealed state.

Muntz Metal is a 60/40 alloy of Cu and Zn. Pb is sometimes added to improve the machinability of the metal. It has a higher strength than cartridge brass.

Bronze is and alloy of Cu and Sn. Sn is generally only added to a maximum of 20% in the alloy and other elements are added to improve the properties

of the metal. The most common bronze is Coinage Bronze, consisting of 95% Cu, 4% Sn and 1% Zn. This alloy is usually used in the production of coins.

Aluminium is the most abundant metallic element in the earths crust, in the form of bauxite. It is much more difficult to weld aluminium than steel and it does not have as high strength. It has an excellent strength-to-weight ratio, the second best of all structural metals. Aluminium is almost never used in its pure form. Most aluminium products that you buy are made of alloys. The 6000 series alloys are the most common and are heavily used for window frames, balustrades and other architectural works. This aluminium alloy has sufficient strength for most wood working applications and is reasonably accessible. The properties of aluminium are heavily affected by the heat treatment it has undergone.

Non-Ferrous metals do not rust. Rust is a ferrous material. Most non-ferrous metals oxidise when the oxide film surrounding the metal has been damaged and is not repaired in time. The base metal is attacked and this attack can lead to early failure of the metal. The film around non-ferrous metals is usually non-porous, self-healing and only one molecule thick.

Glass

Glass is generally available in sheet form and this is the most common form used in woodwork. Window glass is the most common type used and is also call Flat-Drawn Glass. This type of glass is used where accuracy of thickness and a high quality surface finish is not required.

Another type of glass that you might come across is Polished Plate Glass. This is finished to an exact thickness and has an excellent surface finish.

Glass is a very brittle material. It has a high strength but the dust particles in the air leave tiny scratches on the surface of glass and cause it to weaken significantly.

Glass can be cut to almost any shape. It can have a variety of finishes applied to it such as staining, tinting, mirrors, painting, frosting, etc.

Polymers

Polymers are commonly referred to as plastics and can be broken into one of two groups. These groups are Thermoplastic Polymers and Thermosetting Polymers.

Thermoplastic polymers are capable of being reshaped after they have set. This allows these polymers to be reused and recycled. Thermosetting polymers cannot be softened once they have cured, so they cannot be reused.

Most finishes and adhesives are polymers. They can be either thermoplastic or thermosetting polymers. Nylon bearings used in drawer runners are another example of polymers that are used in woodwork.

Thermosetting polymers generally have a higher strength than thermoplastics because of the cross linking present at a molecular level. It is also this cross-linking that prevents the polymer from being softened when it is reheated.

Most polymers have low densities, good thermal and electrical resistance, are available in a wide range of colours, have low strengths and have poor dimensional stability.

Rubber is another polymeric material. This can be either natural or synthetic. Rubbers are an elastomer and are characterised by having high elastic limits. Typically they are very stretchy.

Upholstery Materials & Basic Upholstery

Upholstering a piece of furniture will provide a softer, more comfortable area to sit on or can be used as a simple decoration. By upholstering furniture the materials used under the padding do not need to be of as high a quality as the exposed materials. Radiata pine is good choice of timber to use in an unexposed area because it is usually strong enough for the job and relatively cheap.

On most occasions you will find it quicker and more economical to have a professional upholsterer a piece of furniture for you, but a simple slip seat or padded panel can be upholstered very easily using materials readily available from fabric and foam stores.

The methods used to upholster a slip seat can also be used for other similar applications.

There are two main methods that can be used to upholster a slip seat and they differ only in the frame or base used. In one case a board is made up in the correct shape for the base, in the other only a frame is made up in the correct shape. Both are easy to do, although the frame based seat will be a little softer to sit on and take longer to manufacture.

The frame base should be cut to the correct dimensions, taking into account how much material needs to be held in place under the seat. The pieces are then marked out, taking into consideration the joining method to be used. Cut the joints, apply the adhesive and cramp the frame.

When the adhesive has dried properly the frame is ready to have the webbing applied. It is important to use the correct webbing as some are stronger than others. The webbing may be a Jute, rubber or synthetic material. Steel springs can also be used in place of traditional webbing. Cut the webbing to the correct lengths so that it can be weaved over and under each strip from back to front and side to side.

Apply the webbing by stapling the strips in one direction first. Then staple one end of the strips running perpendicular to the first lot. Weave the strips over and under the perpendicular ones and staple the other end. The webbing is complete when this has been done to each strip. The side with the webbing attached is the top of the seat.

The board style base is generally made by using a manufactured board, such as

plywood, and cutting it to the correct shape. No webbing is required when using a board base.

50mm thick high density foam should be used for the main padding of the seat. Sit the base on top of this and trace around it using a felt tipped marker. Cut the foam using a hot wire cutter, bandsaw or knife.

When the foam is the right shape apply contact adhesive to the side edges of the foam and also in a 50mm thick band around the base of the seat. When the pieces have been allowed to go tacky the foam should be joined to the seat base. The side edges must be rolled under so that the contact adhesive will bond. This will also give a rounded feel to the seat instead of having square edges.

The fabric can be applied over the top of the high density foam or a layer of low density foam can be applied. The second layer of foam is stapled in place under the seat and should be pulled tight so that there are no creases. The staples should be 20mm in from the edge of the frame and 30mm apart.

The covering material can be a fabric, vinyl or leather material. It needs to be cut so that at least 50mm extends under the seat so that it can be gripped and pulled tight. Make sure that the covering material is on straight if it has a pattern on it. Place the covering material on a bench and the seat on top of the cover so that an equal amount of material is showing around each edge.

Fold the cover around the frame on one side only. Start stapling in the middle of the fabric at 25mm in from the edge. Staple along the edge until you reach about 60mm from the corner. Repeat the process on the opposite edge. Make sure that the fabric is pulled tight and there are no creases.

Staples can be removed using pincers if they are in the wrong place.

Repeat the above process for the last two edges.

Fold the back corners first and cut the back edge at 45º. Tuck this edge under the side edges and staple them in place. Make sure the staples are tight. Do the same for the front corners.

Trim the excess fabric close to the staples and hit any loose staples in with a hammer.

A dust cover can be applied to the under side of the seat. Cut the fabric, usually calico, large enough so that you can fold a 10mm edge around it and still have overlap on the fabric. Staple it in place, making sure that it is pulled tight.

Exposed staples or nails can be covered with upholstery tacks. These will give a decorative appearance to the work while hiding fasteners.

Composite Materials

Making a composite material involves combining two or more materials and producing a material that exhibits distinctly different properties to those that make the new composite material. Wood is actually a composite material consisting of long cellulose fibres held together by amorphous lignin.

Composite materials can be roughly categorised into four groups, they are: Agglomerate materials, Laminates, Surface Coated materials or Reinforced materials.

The best example of an agglomerated material is concrete. This contains aggregate, sand, cement and water. Each of the parts has a particular function. Particleboard could also be thought of in this way. It consists of a top and bottom layer of fine pine chips, a middle layer of larger pine chips, bound in a formaldehyde matrix and covered with a veneer. Each part of the particleboard has a function.

Laminates are easy to identify. Probably the most recognisable laminated material in woodwork is plywood. Laminates are formed by applying layer upon layer of material to each other. A large number of glass windows are laminated to make the final product stronger. Laminated glass usually contains internal and external layers of glass sandwiching a thin layer of polymeric material.

Surface coated materials are generally used to prevent corrosion or for decorative purposes. Zinc coated steel or galvanised steel is a good example of surface coated materials.

Reinforced materials use a dispersed phase, strong fibre, thread or rod to strengthen materials. Reinforced concrete is probably the most popular reinforced material used today. This involves placing steel rods or cables through a section of concrete. This is done because concrete has excellent compressive strength but low tensile strength, whereas steel has good tensile strength. There are various methods used to produce reinforced concrete.

Adhesives

The Egyptians were the first to document the use of adhesives in around 3000BC. The Egyptians used natural glues made from animal products and other substances, but today there is such a wide range of adhesives that you must know which one you want or at its service conditions. Many have very specific uses and nearly all adhesives have a shelf life or expiry date.

Some important issues to consider when selecting adhesives include:

- Shelf Life - How long the adhesive can be stored for before it becomes useless.
- Assembly Time - Is the time between applying the adhesive and the fitting of the members.
- Clamping Time - How long the job should be left in the cramps.

- Setting Time - Describes how long it takes for the adhesive to achieve maximum strength.
- Gap Filling Properties - The ability of the adhesive to fill gaps.
- Rigidity - How brittle is the adhesive upon drying.

The mechanism that glues and adhesives use to set is different depending on the base of the adhesive. Water based adhesives and glues such as PVA or casein set because they lose water. Solvent based adhesives such as contact adhesives set because they lose solvent. Epoxy resins set because of a chemical reaction that occurs when the hardener or catalyst is added.

PVA

PVA (Poly Vinyl Acetate) is the most common woodworking adhesive used today. It has a good assembly time and once joined it achieves a high degree of strength after 60 minutes. PVA can be used in many applications such as veneering, carcass construction and widening joints. When veneering with PVA water should be added to the mixture to thin the glue out and make it easier to apply and spread. This adhesive is fungus resistant, has good gap filling qualities and a long shelf life. It is not heat resistant to temperatures above 65°C or water resistant. Finishes cannot be applied over PVA; it must be removed before it dries. A special PVA called Yellow Glue or Aliphatic PVA is used to join manufactured boards, particularly MDF. This is a cross-linking PVA that has higher bond strength than standard PVA.

Epoxy Resins

Epoxy Resin is a generic term for a range of two part adhesive mixtures. The two parts of the adhesive are the resin and a hardener/catalyst. The strength of the adhesive is dependant on the ratio of resin to hardener. Most epoxy resins have a long curing time, even the “five minute” epoxy resins don’t achieve full strength for hours after they have been mixed. When they do gain their full strength the epoxy resin group of adhesives are some of the strongest around, easily stronger than PVA, however this high strength also causes them to be very brittle. They good gap filling qualities that cane be enhanced even further by adding some microfiber, pigment, fine wood dust or a combination of these to the adhesive. Epoxy resins are very expensive and have a limited shelf life. Clean up is difficult as the commonly used

solvents in the wood workshop are not very effective in removing the adhesive.

Hot Melt Glues

Hot Melt glues are those like the hot glue gun type adhesives. They are generally available in a stick form and used with a heat source to become semi liquid. Hot melt adhesives are usually a form of thermoplastic so they can be softened after they have been applied. They can be used to temporarily hold pieces in place until a more secure adhesive can be applied or for quick model building of a project.

Formaldehyde Adhesives – Urea & Resorcinol

Formaldehyde Adhesives are a group of Epoxy Resins. They include urea, phenol and melamine formaldehydes. They are a thermo-setting polymer that is formed by adding a hardener/catalyst to the resin. The catalyst sets off the hardening process. Once this process has begun it cannot be reversed and there is no way of softening the resultant polymer once it has hardened.

Urea Formaldehyde is one of the most commonly used adhesives in industry. It is used in the formation of MDF and particleboard. Both powder and liquid forms are available. Being an epoxy resin, this adhesive has a short shelf life. It scrapes off work cleanly and easily because it becomes brittle upon hardening. This brittleness can lead to early fracture of highly stressed joints, so it is best used for widening joints, laminating timber and applying veneers.

Resorcinol is a phenol formaldehyde resin, black in colour. It is a marginally less toxic but more expensive alternative to Urea Formaldehyde glue. It has high strength and is often used in the construction of laminated beams and

other structural engineered wood products. Like Urea Formaldehyde it must be mixed before use and is available in either liquid/liquid or liquid/powder forms. It is also resistant to high temperatures and water resistant.

Contact Adhesives

Contact Adhesives are not usually used for timber-to-timber joints. This form of adhesive is very good at joining leather, edge veneer and polymeric materials to timber. The adhesive is applied to both surfaces being joined. They are allowed to sit for a specific amount of time, after which the adhesive will become tacky. Once it has become tacky the pieces are joined and the bond usually becomes permanent. When joining sheets of material to timber it is not necessary to apply cramps to the panel, but it is necessary to apply pressure from the middle outwards to avoid trapping air under the sheet.

Animal Glues

Animal Glue used to be one of the most common woodworking glues around. It is generally made using horse hooves and the hides of cattle. Animal glues are non-staining; therefore they will not change the colour of the timber. They are very strong and durable in dry conditions; however they are not water resistant. Assembly time of projects using animal glue is very short because the adhesive must be used while hot.

Casein Glue

Casein Glue is made from sour milk and treated with acids. This glue provides an excellent working time and has good gap filling properties but nearly all forms of the glue will stain timber.

Polyurethane Adhesives

Polyurethane Adhesives are becoming popular in Australia for a number of reasons including: ease of application, water resistance, and good gap filling

properties. It is more expensive than PVA and has strength similar to or greater than cross linking PVA adhesives. The good gap filling properties of polyurethane adhesives are present because as the adhesive sets it expands.

Super Glues

Cyanoacrylate is an extremely common adhesive usually known as Super Glue. Drying time is very short, meaning that clamping is virtually impossible. Various formulas of cyanoacrylate adhesives are available, some even in two part mixtures that allow longer setting times, however they are very expensive.

Review Questions – Other Materials used in Woodwork

1. Consider all of the listed properties for any materials that may be used in the construction of your Major Project. This is best done in a table format.

2. What is the difference between ferrous and non-ferrous metals?

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3. What metal is used for bandsaw blades, circular saw blades, plane blades, plane soles, Bosch router bodies, step cone vee belt pulleys on lathes?

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4. What are two common types of brass and their compositions?

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5. Where could brass be used in your Major Project? Why or why not will it be used?

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6. How is glass cut in a straight line?

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7. What is a common type of thermoplastic used in the workshop? Use the trade name and chemical name.

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8. Different adhesives are used for different applications. In carcass construction and widening joints, biscuits are commonly used as a method of joining pieces. What glue is used? Why is this specific glue used?

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9. MDF can be glued using a special type of PVA. What is the difference and how is it distinguished from standard PVA?

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10. What applications could the hot glue gun have in the workshop?

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11. What does it mean when we say that Formaldehyde adhesives are a thermo-setting plastic? What is a disadvantage of this sort of adhesive?

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12. What are some uses for Phenol Formaldehyde and Melamine Formaldehyde?

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13. Why does animal glue have a short assembly time?

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14. Contact adhesive is good for veneering but what must be done to achieve a good glue-up?

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15. List the advantages and disadvantages of PVA glue.

Advantages	Disadvantages

16. What are the two parts of an epoxy resin? What does each part do?

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10. Explain how these types of adhesives set and provide an example for each:

Water Based	Solvent Based	Epoxy Resin
Example:	Example:	Example:
Setting Mechanism:	Setting Mechanism:	Setting Mechanism: