

Material Properties	
Strength	The ability of a material to resist an applied force
Tensile Strength	The maximum pulling force a material can withstand before failure
Yield Strength	The amount of stress at which the material will reach plasticity
Ultimate Tensile Strength (UTS)	The amount of stress at which a material breaks
Compressive Strength	The resistance of a material under a pushing force
Ductility	The amount that a material can be stretched while being deformed
Malleability	The ability of a material to be deformed without breaking
Hardness	The ability of a material to resist wear and abrasion
Toughness	The ability of a material to withstand an impact without breaking
Brittleness	The potential for a material to shatter when experiences an impact
Stiffness	The ability of a material to resist bending
Elasticity	The ability of a material to return to its original shape when the load upon its removed
Plasticity	When you stretch a material and it doesn't return to its original shape once the force is removed

Calculations	
Stress	The force per unit area of a material- N/mm^2
Stress Equation	$\text{Stress} = \text{force} / \text{cross sectional area}$
Stress Symbol	$\sigma = F/A$
Strain	The ratio of an amount a material is extended to its original length
Strain Equation	$\text{Strain} = \text{Change in length} / \text{Original length}$
Strain Symbol	$\epsilon = \Delta l / l$
Young's Modulus	The measure of how much force is needed to stretch or compress a substance- N/mm^2
Young's Equation	$\text{Young's Modulus} = \text{Stress} / \text{Strain}$
Young's Symbol	$E = \sigma / \epsilon$
Factor of Safety	How much stronger the product is than it needs to be for expected loading
FoS Equation	$\text{FoS} = \text{Yield Stress} / \text{Load Stress}$
FoS Symbol	$\text{FoS} = \sigma_y / \sigma_L$

Metals and Alloys	
Ferrous Metals	Contains iron Generally tougher and stronger They are magnetic
Non-Ferrous Metals	Doesn't contain iron Malleable and ductile They are not magnetic
Alloys	Made from two or more base metals to improve properties

Ferrous Metals

Metals and Alloys (cont)	
Cast Iron	3-3.5% Carbon Cheap, rusts easily, hard, good compressive strength Anvils, vices
Low Carbon Steel	Less than 0.3% Carbon Lower strength, tough, cheap Nails, Car bodies
High Carbon Steel	0.8-1.4% Carbon Strong and tough Difficult to form Saw blades, hammers
Stainless Steel	At least 11.5% Chromium Strong, hard, expensive Difficult to machine Good corrosion resistance Cutlery

Non-Ferrous Metals

Aluminium and its alloys	Light, soft, ductile, malleable Good conductor of heat and electricity Corrosion-resistant Aircraft bodies, foil, saucepans
Copper	Tough, malleable Good conductor of heat and electricity Easily Joined Wires, printed circuits
Brass	65% Copper and 35% Zinc Casts well, easily joined Castings, boat fittings
Bronze	90% Copper and 10% Tin Tough and hardwearing Bearings, coins, water and steam valves



Metals and Alloys (cont)

Lead Very soft, low m.p, heavy common metal
Roof coverings

Zinc Poor strength-weight ratio, low m.p
Coating steel

Polymers

Polymers A plastic

Thermo-plastic Polymer Can be reshaped when heated

Thermo-setting Polymer Cannot be reshaped when heated

Thermoplastic

ABS Strong and rigid Toys
Keyboard

Acrylic Transparent, hard wearing Plastic
Windows
Bath tubs

Nylon Ductile, durable Gear wheels

Polyca-bonate High Strength Heat resistant Safety glasses
DVDs

Polyst-yrene Tough, Good impact strength Packaging,
Foam cups

Thermosetting

Epoxy Stiff and brittle Temperature, Chemical and Electrical resistance Circuit boards,
Electrical insulator

Polyester Resin Cheap, good strength and stiffness Suitcases

Melamine Resin Resistant to some chemicals and stains Laminate coverings for kitchen worktops

Polymers (cont)

Polyur-ethane Hard with high strength Flexible and tough Low thermal conductivity Hoses,
surface coatings and sealants

Vulcanised Rubber Elastic, High tensile strength, resistant to abrasion Tyres,
shoe sales, bouncing balls

Composites, Ceramics & Timber

Composites A type of material made by combining two or more different types of materials

Reinforcement The particles of fibres within a composite matrix that increases its strength

CRP: Carbon fibres in an epoxy resin matrix Extremely high strength, Low density, Expensive Racing bicycles
Helmets

GRP: Glass fibres in a polyester resin matrix High strength, Good chemical resistance, Lower cost than CRP Canoes
Water tanks

Plywood: Layers of wood bonded at 90° to each other, using adhesive matrix Smooth surface and good strength, May be covered in veneer Furniture
Boat building