Engineering Materials Cheat Sheet

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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	Stress= force/cross sectional area
Stress Symbol Equation	σ= F/A
Strain	The ratio of an amount a material is extended to its original length
Strain Equation	Strain= Change in length/Original length
Strain Symbol Equation	ε= Δl/l
Young's Modulus	The measure of how much force is needed to stretch or compress a substance- **N/mm^2**
Young's Equation	Young's Modulus= Stress/Strain
Young's Symbol Equation	E= σ/ε
Factor of Safety	How mcuh stronger the product is than it needs to be for expected loading
FoS Equation	FoS= Yield Stress/Load Stress
FoS Symbol Equation	FoS= σy/σL

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-rbonate	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