Properties and testing materials

Understanding the physical properties of materials

Understanding that materials can be defined by a range of properties, for example:

- **tensile strength** – the ability of a material to resist stretching or breaking when pulled
- **compressive strength** – a materials ability to withstand loads without changing its shape
- **hardness** – this is a materials ability to resist changing shape when impacted by another object
- **toughness** – the ability of a material to absorb energy (impacts) before it starts to deform (change shape)
- **malleability** – the materials ability to be repeatedly hammered, pressed, bent or rolled into thin sheets
- **ductility** – the ability of a material to be drawn or plastically deformed without breaking
- **conductivity** – a measure of how well the material conducts heat or electricity
- **corrosive resistance** – how well the material can withstand damage caused by chemicals or oxidisation
- **elasticity** – the ability of a material to limit distorting and return to its original shape and size
- **environmental degradation** - how the physical environment is degraded, damaged or compromised through a range of situations such as air pollution, water contamination etc.

Physical properties required for specific products (examples)

Mobile phones

- **compressive strength** to resist weight put on the phone casing
- **corrosive resistance** to limit damage to the phone casing from chemicals such as hairspray, sun cream or other daily exposures.

Security alarm

- **compressive strength** in its casing to avoid deformation from high winds
- **hardness** to avoid possible vandalism or attempts to gain access to the circuit.

Bicycles

- **ductility** to allow the tubular forms of the frame to be created (drawn)
- **toughness** to absorb impact, for example when children drop bikes on the floor or during a crash in a race
- **compressive and tensile strength** to absorb the shifting weight of the cyclist on the bike.

Children's play area

- **toughness** to absorb impact when children climb frames and obstacles
- **elasticity** when children climb ladders and ropes or walk across suspended bridges
- **compressive strength** to withstand loads of several children standing in a small area or climbing on frames
- **tensile strength** when children hang or swing on sections of the play area.

How materials are tested to determine their physical properties

Testing is undertaken in engineering to determine the physical properties of materials.

Destructive testing will test the material, part or product until it breaks or is destroyed. Non-destructive testing is used to evaluate the property of the material without causing it damage.

Tensile testing - the material or part is clamped in two locations, usually on opposite ends, and increasing pulling force is applied in opposing directions to measure stretching.

Hardness testing - this is tested by indenting the material with a known hard material such as diamond. The force used to create this is measured to determine hardness.

Toughness testing – this is undertaken by allowing a pendulum with a mass on the base to strike the side of the material or part. The extent to which the shape bends (deflects) dictates its level of toughness.

Malleability testing is done by applying a stamping action (pressing) on the material to see how much the malleable material will flatten without breaking.

Ductility testing is performed in a similar manner to tensile strength testing, where the material is drawn apart.

Conductivity testing is done by passing an electrical current through the metal material and measuring its resistance.

Elasticity is another stretching test but measures a material's ability to be stretched without permanent deformation.