2.3.1 Properties of materials 1

Key terms relating to materials

Term	Definition
Strength	The ability to withstand an applied load without failure.
Toughness	The ability to absorb energy and plastically deform without fracturing. To be tough, a material must be both strong and ductile.
Hardness	A measure of resistance to mechanical indentation or abrasion. Examples include ceramics and concrete.
Brittleness	Brittle materials such as glass will fail when subjected to stress, with little or no prior plastic deformation.
Malleability	A malleable material can be re-shaped by hammering, pressing, or rolling without breaking it.
Ductility	Similar to malleability, this is the degree to which a material can sustain tensile stress before failure.
Resilience	The ability of a material to return to its original shape following compression.
Resistance (to creep and slip)	Resistance to time dependent deformation under an applied load (creep).
Resistance to fatigue	Resistance to cracking caused by cyclic loadings. This is traditionally associated with metals (metal fatigue) where cracks grow with each loading and eventually cause a fracture.

Key terms relating to structures

Term	Definition
Stress	Force per unit area – the internal reaction to an applied force.
Tensile stress	Tension – a force that tends to elongate or enlarge an object.
Compressive stress	Compression – a force that tends to shorten or crush an object.
Shear stress	A force acting parallel to an imaginary plane cut through an object.
Strain	Deformation of a solid due to stress.

Changing conditions

Air temperature – expansion and contraction of materials caused by variations in temperature can induce strain and result in cracking, and other forms of deformation.

Different materials will have different rates of thermal expansion. In brickwork, thermal expansion can cause mortar and bricks to crack, allowing rainwater to penetrate. Detailing should include 10mm-wide vertical expansion joints, at 6m-10m centres.

Problems may develop in concrete structures unless properly spaced joints to accommodate temperature movement are incorporated. Also, placing concrete in cold weather should be avoided as it may affect curing and prevent the concrete from reaching its design strength.

Humidity and condensation – condensation occurs when air that has reached its dew point comes into contact with cooler surfaces. Air reaches its dew point when the relative humidity (the amount of moisture in the air at a certain temperature compared to what the air can "hold" at that temperature) reaches 100%.

Moisture can form as interstitial condensation when air moves from a warm interior to a cool exterior and reaches its dew point within the building fabric.

Condensation can cause problems such as mould growth, mildew and staining and may result in damage to equipment, corrosion and decay in the building fabric and reduced performance of insulation.

Condensation can be controlled by limiting sources of moisture, improving ventilation, increasing air and surface temperatures, avoiding cold bridges and using dehumidifiers.

Precipitation – pollution in the atmosphere may combine with water to form acid rain. This can damage marble and limestone, affect the compressive strength of concrete, and lead to the corrosion of steel reinforcement.

Most species of timber deteriorate when exposed to rain; exceptions include cedar, redwood, and teak, which contain natural oils that safeguard them against moisture. Other species need the initial protection of a preservative, impregnated, or applied as a surface finish, and regular maintenance, to retain strength, to prevent warping and cracking and to resist the action of the micro-organisms that cause rot and decay.

Corrosion converts a metal to its oxide, and thereby affects its strength and appearance. It requires the presence of water and oxygen; if either are absent corrosion does not occur.

Measure to protect structural steelwork from corrosion include specialised coatings and galvanisation (coating in zinc). However, this form of protection may be insufficient for components exposed to acid rain, or in a salt environment, such as coastal locations, where stainless steel should be used.