2.3.2 The properties of construction materials 1

Key terms

Term	Definition
Durability	The ability to resist the adverse effects of weathering, chemical attack, and abrasion.
Coefficient of thermal expansion	The rate at which the size of a material changes with respect to temperature change.
Galvanising	The process of coating that is intended to prevent corrosion.
Flexural strength	The capacity of a material to resist deformation under bending moment.

The main properties of concrete

Mass or plain concrete is one of the most used building materials. It is often used for the construction of roads and pavements and where building components do not require high tensile strength, such as ground bearing foundations. The constituents are cement, sand and aggregate, mixed with water, typically in the ratio 1:2:4.

Compressive strength is the most common and well-accepted measurement of concrete strength, used to assess the performance of a given concrete mix. It measures the ability of concrete to withstand loads that will decrease the size of the concrete and is tested by measuring the force required to crush cubes of the mix after seven days and 28 days of pouring, to check that the specified compressive strength is being achieved.

Other properties include being an effective barrier to noise and having a high degree of fire resistance. It is porous and is subject to shrinkage during the initial drying process.

Reinforced concrete – to increase its overall strength, steel rods, wires, or mesh can be embedded in concrete before it sets (or placed before the concrete is poured). The reinforcement resists tensile forces, whilst concrete resists compressive forces. The two materials combine to resist a variety of applied forces and act as a single structural element. The coefficient of thermal expansion of concrete and steel are similar and therefore any internal stress due to expansion is limited.

Pre-stressed concrete allows for designed engineering stresses to be placed in the reinforcement during manufacture, to counteract the stresses that will be imposed under load. In ordinary reinforced concrete, stresses are carried by the reinforcement, whereas prestressed concrete supports the load by the stresses induced throughout the structural element, making it possible to form long, thin structures with relatively small sectional areas.

Main properties of steel

Steel is an alloy of iron and other elements such as carbon. It has high compressive and tensile strength and is a poor conductor of heat, making it suitable to use in high temperature environments.

Mild steel is a low carbon steel that is ductile and can be drawn without fracturing. Mild steel is one of the most commonly used materials in construction due to its proven strength and durability. Steel construction has many advantages including an excellent strength-to-weight ratio. It can be joined by welding, and easily bolted/riveted together and can be formed into efficient structural shapes.

Hot-rolled mild steel is commonly used to form structural steel beams and columns by passing heated steel between large rollers, which deform it into the required shape, such as I sections, channels, and angles, etc.

Cold rolled steel sections are formed by bending and shaping sheet steel at room temperature using a series of specially designed rollers. The process can be used to manufacture typical shaped sections and more complex profiles, such as purlins, lintels, sheeting rails, and partition studs, etc.

Galvanised steel is manufactured by a process that involves dipping steel into molten zinc which hardens to form a protective, anti-corrosive coating through the formation of zinc oxide. The zinc coating on galvanised steel eventually wears off, and if it is scratched or damaged in any way, it can become susceptible to rust.

Its use is typically restricted to applications where there is minimal risk of damage. Galvanised steel is significantly less expensive than stainless steel, and is commonly used, for example, to make nuts, bolts, and other fixings, and for the protection of cold rolled sections, including the examples listed above.

Stainless steel contains 10% or more chromium. This content gives the steel a higher corrosion resistance, making it suitable for use in water and places such as coastal environments where there will be a high salt content in the air and water. Due to its make-up, stainless steel has higher compressive and tensile strengths and greater ductility than mild steel.

Fire resistance – structural steel can withstand approximately 425°C before it begins to soften. Between 600°C and 650°C, the steel will lose half of its strength, and may fail (even a house fire can reach very high temperatures of around 600°C).