2.3.2 The properties of construction materials 2

The main properties of timber

Hardness – the hardness of timber varies depending on the type of wood being used. Typical softwoods used in construction include various types of pine, larch and spruce. Hardwoods used in construction include oak, maple, mahogany, cherry, walnut and teak.

Hardwoods tend to be used for the construction of walls, floors and ceilings, whereas softwoods are used for items such as doors and windows.

Strength – timber is strongest along the grain rather than across the grain. The strength parallel to the grain can be 20-30 times stronger than when sawn across the grain.

Fire resistance – when timber chars at a constant known rate. Periods of fire resistance can be increased with the use of over-sized sections.

Shrinkage and swelling – timber is subject to shrinkage and swelling dependent on air conditions. Humid air causes timber to swell, whereas dry conditions cause timber to shrink.

The main properties of bricks

Hardness – bricks are formed of a hard material and therefore do not deform easily in a construction.

Compressive strength – bricks have a high compressive strength and are well suited to use in load bearing walls.

Flexural strength – this makes brick suitable for use in situations where bending loads may be imposed on the structure.

Durability – bricks are durable and have a long service life. The durability of bricks is directly related to the material hardness.

Frost resistance – bricks can resist water percolation which leads to good levels of frost resistance.

Efflorescence – this is the process when salts from within a brick wall come to the surface to form white deposits. It tends to happen in cold and wet conditions.

The manufacture of materials

Cement – raw materials, mainly limestone and clay, are quarried and then crushed. The crushed rock is combined with other ingredients such as iron ore, ground, mixed, and fed into a cement kiln. The cement kiln heats all the ingredients and certain elements are driven off in the form of gases to form clinker. The clinker is then cooled, mixed with gypsum, and crushed into a fine powder.

Concrete – a mixture of cement, water, sand and coarse aggregates, or rocks. The cement water mix coats the surface of the fine (small) and coarse (larger) aggregates. Through a chemical reaction called hydration, the paste hardens and gains strength to form a rock-like mass.

Steel – raw inputs of iron ore, coke, and lime are melted in a blast furnace. Oxygen is blown through the molten metal to reduce the carbon content, and other elements, possibly including scrap steel, are added depending on the type of steel required. The molten steel is cast into a mould, fully cooled and solidified ready for cutting and primary forming, by hot rolling; this is followed by secondary forming, including cold rolling or shaping, machining and surface treatment.

Timber – 'felling' is the process of cutting down individual trees (felled trees should be replaced with saplings to ensure a sustainable resource). Felled trees are cut and transported to a sawmill, where the timber is converted into boards by sawing and planing. The timber is then seasoned to reduce its water content, making it less likely to warp or deform, and treated with preservative ready for use.

Brick – raw materials such as clay are crushed and blended and then shaped, usually by extrusion. The bricks are then dried to remove excess moisture, fired in ovens and cooled, ready for use.

The effects of temperature

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

In brickwork, thermal expansion can cause the cracking of mortar and bricks, 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, the cold weather placing of concrete should be avoided as it may affect curing and prevent the concrete from reaching its design strength.

Similar detailing is required for steel structures and sheet finishes as dimensions increase with temperature. Very high temperatures can cause a reduction in strength and stiffness and steel becomes more brittle at low temperatures.

Load-bearing properties

Concrete has high compressive strength, which increases over time. Requires reinforcement to improve poor tensile strength.

Steel has a high strength capacity in both tension and compression and a high strength-to-weight ratio. Steel structures perform well under lateral loads (high winds etc.) due to their ductility, which is the ability to bend without breaking.

Timber has the potential for good strength capacity in both tension and compression, depending on the type and shape of the timber.

Brick has a high compressive strength, depending on the strength of the bricks or blocks and the mortar used.