Student 1: Low Excellence

Concrete is produced by mixing cement, water, sand and stones (or rocks) into a paste. Portland cement is the basis of concrete – the substance that, together with water, holds sand and stones together. This occurs when the cement dries and hardens.

Cement hardens because of a chemical reaction. Cement is able to harden due to the water that is added in its mixture. The water causes bonds to form between it and the cement which eventually harden to its more functional form. The amount of water added is also a key factor to how strong cement will be. Cement used in construction can be characterised as being either hydraulic or non-hydraulic. Hydraulic cement (e.g. Portland cement) hardens because of the addition of water, a chemical reaction between the dry cement powder and water. The chemistry ruling the hardening (setting) of the hydraulic cement is the addition of water. Hydraulic cement (such as the Portland cement) is made of a mixture of silicates and oxides, with four main components. One component being: tricalcium silicate (Ca_3SiO_5). When hydraulic cement sets a chemical reaction occurs between tricalcium silicate and water. When water is added, tricalcium silicate reacts and releases calcium ions, hydroxide ions and heat. The pH rises due to the release of hydroxide ions. This reaction continues slowly until the system becomes saturated and calcium hydroxide starts to crystallise. On the other hand, non-hydraulic cement such as slaked lime (calcium hydroxide mixed with water) hardens due to the reaction with carbon dioxide naturally present in the air. The calcium containing compounds in the cement react with CO_2 from air and are converted to calcium carbonate. Removal of calcium hydroxide produces calcium oxide at temperatures above 825 °C (1517 °F) for about 10 hours at atmospheric pressure.

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