Technical Advice Note

The Hydration Process

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The Hydration Process

During the placing and setting of concrete, a chemical reaction occurs between the cement and water called the hydration process.

Portland cements are a mixture of compounds made by burning limestone and clay together at very high temperatures (1400-1600 C): There are five major compounds and a few minor compounds; see table below.

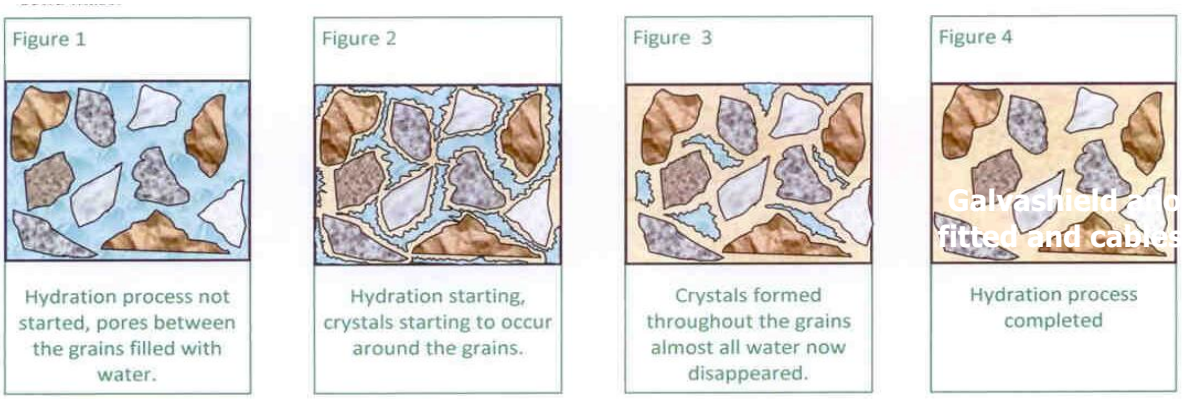
Compound	Weight %	Chemical Formula
Tricalcium silicate	50%	**Ca_3SiO_5 or $3CaO{\cdot}SiO_2$**
Dicalcium silicate	25%	**Ca_2SiO_4 or $2CaO{\cdot}SiO_2$**
Tricalcium aluminate	10%	**$Ca_3Al_2O_6$ or $3CaO{\cdot}Al_2O_3$**
Tetracalcium aluminoferrite	10%	**$Ca_4Al_2Fe_2O_{10}$ or $4CaO{\cdot}Al_2O_3{\cdot}Fe_2O_3$**
Gypsum	5%	**$CaSO_4{\cdot}2H_2O$**

As the water is added each compound undergoes this hydration process, each adding its own properties.
The two calcium silicates give the concrete strength.

The Tricalcium aluminate and Tetracalcium aluminoferrite react with the gypsum

When the water is added the tricalcium silicate rapidly reacts exothermically (Chemical reaction accompanied by heat), releasing calcium ions and hydroxide ions. This calcium hydroxide raises the pH to 12.6 +. The initial reaction slows down quite quickly along with the amount of heat generated. The reaction continues at a slower rate still producing the calcium hydroxide ions until saturation, at which point the calcium hydroxide starts to crystallize.

At this stage calcium silicate hydrate begins to form as well, and the combination of calcium hydroxide and calcium hydrate crystals form the basis on which further crystals can form, eventually turning the water between the grains of aggregate into solid mass.



Steel reinforcement bars within concrete (pH value of 9+) benefit from the hydration process, as a passive layer is formed around the steel protecting it from corrosion. Providing the concrete is properly mixed and placed (well compacted and dense) this protection will last for many years.

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