

## C - 20: High Performance Concrete

A few years ago, 6000 psi (41 MPa) concrete was considered high compressive strength concrete. Today concrete with a compressive strength near 20,000 psi (138 MPa) is commercially available as High Performance Concrete (HPC). HPC projects are becoming popular in North America and the most common applications are in building columns, bridge superstructures and decks, and parking decks.

HPC, using high performance admixtures, silica fume, and other supplementary cementing materials makes concrete easier to place, stronger, more durable, and more corrosion resistant than normal strength concrete. The main difference between HPC and normal strength concrete is the density of the cement paste - the density is higher in High Performance Concrete. This is accomplished by reducing the water-cement ratio that leads to more uniform distribution of the cement particles, thus reducing the porosity.

High performance admixtures, such as superplasticizers, fluidize the mix, deflocculate the cement particles and help reduce the water-cement ratio. A dense cement paste resulting from a low water-cement ratio HPC mix results in the cement grains chemically reacting quickly and extensively producing a high compressive strength. Since less mixing water is required in HPC than in normal strength concrete for the same workable concrete consistency, a lower porosity is developed in HPC which also produces higher compressive strengths.


HPC, with strengths up to 12,000 psi (83 MPa),

has been successfully produced using high performance admixtures. For compressive strengths in excess of 12,000 psi (83 MPa), it is generally recommended that silica fume (or micro silica) be added to the concrete mix.

Silica fume is a pozzolanic material, containing at least 85% silicon dioxide, and is about 50 times finer than cement. Silica fume is usually handled in a slurry form for ease of use and usually has a superplasticizer incorporated with it in the slurry for workability when added into a concrete mix.

Normal strength concrete, during normal cement hydration, produces undesirable cement hydration products, such as calcium hydroxide, which do not contribute to the strength gain of the concrete. A pozzolanic material is one that contains silicon dioxide, and this silicon dioxide, as in silica fume, reacts with the calcium hydroxide to produce desirable strength gaining cement hydrates in the concrete.

The pozzolanic reaction takes place very quickly and extends for a long period with concrete containing silica fume. The result is a low porosity HPC with not only a very high ultimate strength but also one with a very high early strength. HPC, containing silica fume, is also highly corrosion resistant. However, the high cost of silica fume is often prohibitive.

Other slower reacting pozzolanic materials, such as certain fly ashes or ground granulated blast furnace slags, are often used in unison with silica fume and superplasticizers in HPC to make the mix more cost effective 

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