

Nanotechnology and concrete construction

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Super tall buildings such as one kilometer high Kingdom Tower are constructed with concrete as a structural material. Such tall buildings are made with so called high performance concrete, which can have strength 5 times that of conventional concrete. The development of high strength concrete is a result of our understanding of particle packing, rheology and microstructure engineering. Concrete is a critical material for infrastructure; the world wide consumption of concrete is about 2 tons for every living human being. However, its continuing use will require improving its sustainability. Nanotechnology is playing an increasing role in making concrete more sustainable. Some examples are given. One approach to making concrete more sustainable is to replace Portland cement (and its significant carbon foot print) with fly ash, a waste material from burning coal.

When fly ash is replaced with Portland cement, the rate of strength development slows down which is not desirable. Addition of Nano particle such as Nano silica accelerates the chemical reaction by providing nucleation sites .In addition, characterization of Nano structure of calcium silicate hydrate by Nano indentation, AFM, FTIR and NMR shows beneficial Nano scale modification. Concrete is a brittle material, prone to cracking. Concrete structures are reinforced by see bars at a millimetre scale. However, flaws in cement paste are in Nano scale. To reinforce concrete at Nano scale addition of carbon Nano tube is studied. The key challenges include dispersion and rheology. Recent studies have demonstrated that adding a very small amount (0.05%) of well dispersed CNT has a profound effect on performance: mechanical properties, piezo-resistivity, transport properties as well as corrosion reinforcing steel. Such multi functionality is probably related to altered Nano structure of concrete.

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