DEPARTMENT OF CIVIL & ENVIRONMENTAL ENGINEERING

DISTINGUISHED SEMINAR

Nanotechnology and Sustainability of Concrete Construction

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Abstract: Super tall buildings such as one kilometre-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 every year. However, its continuing use will require improving its sustainability. Nanotechnology is playing an increasing role in making concrete more sustainable. Some examples are given in this talk.

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.

Manipulation of concrete rheology has been a key to make concrete more constructible. The viscosity should be sufficiently small so that concrete can be pumped a great distance, but the material should be thixotropic to reduce the pressure on form work. Addition of a small amount of nano clay has been shown to accelerate the rate of thixotropy. Rheology of aging colloidal suspension is being studied by computation modeling as well as by measuring the dimensions of flocculated particles by using laser spectrometer.

Concrete is a brittle material, prone to cracking. Concrete structures are reinforced by see bars at a millimeter 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.

Bio-sketch: Professor Surendra P. Shah was the founding director of the pioneering NSF's science and Technology Center for Advanced Cement-Based Materials. His current research interests include: fracture, fiber-reinforced composites, nondestructive evaluation, transport properties, processing, rheology, nano-technology, and use of solid waste materials. He has co-authored two books: Fiber Reinforced Cement Based Composites and Fracture Mechanics of Concrete. He has published more than 500 journal articles and edited more than 20 books. He is past editor of RILEM's journal, Materials and Structures. He is currently co-executive editor of the Journal—Frontiers of Structures and Civil Engineering. He is a member of the US National Academy of Engineering. He is also a foreign member of the Chinese Academy of Engineering the Indian Academy of Engineering, Athens Academy and the Russian Academy of Engineering. He has received many awards, including the Swedish Concrete Award, American Concrete Institute's Anderson Award, RILEM Gold Medal, ASTM Thompson Award, American Society of Civil Engineer's Charles Pankow Award, and Engineering News Record News Maker Award. He was named one of the ten most influential people in concrete by Concrete Construction Magazine. He has been awarded an honorary membership in American Concrete Institute and RILEM .