



**SURENDRA P. SHAH**



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## **Spring 2018 Khan Distinguished Lecture Series**

*The Fazlur Rahman Khan Distinguished Lecture Series honors Dr. Fazlur Rahman Khan's legacy of excellence in structural engineering and architecture*

*Initiated and Organized by* **PROFESSOR DAN M. FRANGOPOL**

The Fazlur Rahman Khan Endowed Chair of Structural Engineering and Architecture  
Department of Civil and Environmental Engineering, ATLSS Engineering Research Center,  
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## **SURENDRA P. SHAH**

Walter P. Murphy Professor of Civil Engineering (Emeritus), Northwestern University,  
Evanston, IL

### **“Sustainability in Concrete Construction Based on Nanotechnology”**

**Friday, February 23, 2018 – 4:30 pm**

**Location: Whitaker Lab 303, Lehigh University, 5 E. Packer Avenue, Bethlehem, PA**

<http://www.lehigh.edu/frkseries>

**Surendra Shah** is Walter P. Murphy Professor (emeritus) at Northwestern University. He was the director of the NSF funded Science and Technology Center of Advanced Cement Based Materials. He is an honorary member of ACI and RILEM and has published over 500 journal articles on various aspects of concrete technology. Prof. Shah is a member of the U.S. National Academy of Engineering, the Chinese Academy of Engineering, and the Indian Academy of Engineering. Currently he is a distinguished professor at IIT Madras, Honorary Professor at Tongji University, Hongkong Poly and Jinan University, and a member of the Institute of Advanced Studies at HKUST.

**Sustainability in Concrete Construction Based on Nanotechnology.** Super tall buildings such as the one km 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.

Manipulation of concrete rheology has been a key to make concrete more constructable. 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 nanoclay can substantially reduce the form work pressure. Concrete is a brittle material, prone to cracking. To reinforce concrete at nano scale addition of carbon nano tube is studied. The key challenges include dispersion and rheology.

**FAZLUR RAHMAN KHAN** (1929 - 1982) One of the foremost structural engineers of the 20th century, Fazlur Khan epitomized both structural engineering achievement and creative collaborative effort between architect and engineer. Only when architectural design is grounded in structural realities, he believed — thus celebrating architecture's nature as a constructive art, rooted in the earth — can “the resulting aesthetics ... have a transcendental value and quality.” His ideas for these sky-scraping towers offered more than economic construction and iconic architectural images; they gave people the opportunity to work and live “in the sky.” Hancock Center residents thrive on the wide expanse of sky and lake before them, the stunning quiet in the heart of the city, and the intimacy with nature at such heights: the rising sun, the moon and stars, the migrating flocks of birds. Fazlur Khan was always clear about the purpose of architecture. His characteristic statement to an editor in 1971, having just been selected Construction's Man of the Year by *Engineering News-Record*, is commemorated in a plaque in Onterie Center (446 E. Ontario, Chicago): **“The technical man must not be lost in his own technology. He must be able to appreciate life; and life is art, drama, music, and most importantly, people.”**

In step with the abounding vitality of the time, structural engineer **Fazlur Rahman Khan** (1929-1982) ushered in a renaissance in skyscraper construction during the second half of the 20th century. Fazlur Khan was a pragmatic visionary: the series of progressive ideas that he brought forth for efficient high-rise construction in the 1960s and '70s were validated in his own work, notably his efficient designs for Chicago's 100-story John Hancock Center and 110-story Sears Tower -- the tallest building in the United States since its completion in 1974.



**Fazlur Rahman Khan**

Lehigh endowed a chair in structural engineering and architecture and has established this lecture series in Khan's honor. It is organized by **Professor Dan M. Frangopol**, the university's first holder of the Fazlur Rahman Khan Endowed Chair of Structural Engineering and Architecture, and sponsored by the Departments of Civil & Environmental Engineering, and Art, Architecture & Design.



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**1 PDH will be awarded to eligible attendees for each lecture**

Please contact the Khan Chair office at 610-758-6123 or Email: [infrk@lehigh.edu](mailto:infrk@lehigh.edu) with any questions.