# Fazlur Rahman Khan

## The Einstein of Structural Engineering

*By Richard G. Weingardt, P.E.*

Most visible among America's impressive list of elite engineering giants are its leading-edge structural engineers, the designers of spectacular bridges, skyscrapers, sports facilities, space-age-looking buildings and national monuments – record-setting complex structures that are often the biggest, tallest, longest and/or first. Foremost on that list is Pakistan native Fazlur R. "Faz" Khan, a structural trailblazer whose breakthroughs in structural engineering for tall and long-span buildings exerted an unprecedented and lasting influence on the profession, both nationally and internationally.

Mir M. Ali, University of Illinois professor and author of *Art of the Skyscraper: The Genius of Fazlur Khan*, said that in addition to being labeled as one of the greatest engineers of our time, Khan was many times referred to as the "Einstein of Structural Engineering."

According to David Billington, coiner of the phrase "structural art," Khan's work exemplified that concept. Said Billington, "The first fundamental of structural art is the discipline of efficiency; a desire for minimum materials, resulting in less weight, less cost and less visual mass." In his many notable skyscrapers, Kahn clearly mastered those objectives, often influencing the final architectural appearance of signature buildings in a major way.

*Sears Tower, now known as the Willis Tower. Courtesy of SOM and Hedrick Blessing.*

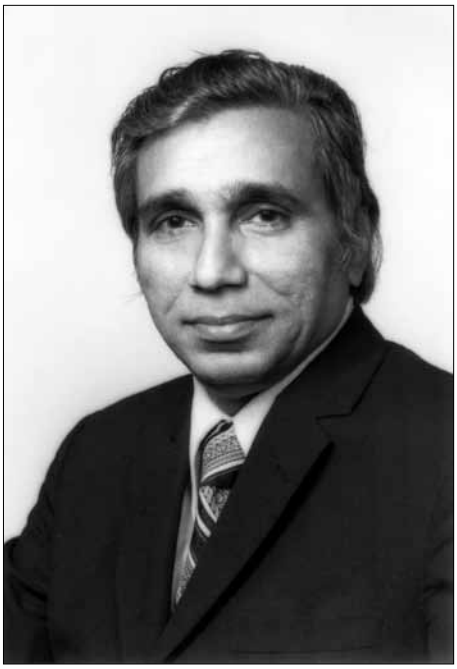
Considered the father of tubular design in high-rises, Khan was a firm believer that meshing the talents of structural engineers and architects always resulted in the best solutions. According to John Zils, senior engineer and associate partner with Skidmore, Owings & Merrill (SOM), "It was his unique ability to bridge the gap between architectural design and structural engineering that truly set Faz apart from other structural engineers." Because of that, Khan became an icon in both architecture and structural engineering.

Born on April 3, 1929, in Dhaka, Bengal (then in British India), Fazlur was the son of Abdur Rahman and Khadija (Khatun) Khan. His father Abdur was a well-respected high school mathematics teacher and the author of several seminal textbooks on the subject. He eventually became the Director of Public Instruction in the region of Bengal. In addition to his father, Fazlur's early decision to become an engineer was influenced by an older cousin who preceded him into college to study engineering.

After completing undergraduate coursework at the Bengal Engineering College, University of Calcutta, Fazlur proceeded to the University of Dhaka, where he received his bachelor's in engineering degree in 1950, finishing first in his class. A Fulbright Scholarship, combined with a Pakistani government scholarship, brought him to the U.S. and the University of Illinois at Urbana. There, he earned two master's degrees – one in structural engineering, and the other in theoretical and applied mechanics – followed by a PhD in structural engineering in 1955.

Khan immediately joined the internationally known architectural and engineering firm of SOM in Chicago. By 1960, he was fast establishing his trademark of pioneering creative concepts for tall buildings framed with structural steel, concrete and/or composite systems. His "tube system," using all the exterior wall perimeter structure of a building to simulate a thin-walled tube, revolutionized tall building design.

In 1962, while designing the 38-story, reinforced concrete Brunswick Building in Chicago, he developed methods for using shear wall and frame interaction to resist lateral forces. Later, he refined this system to come up with the "tube-in-tube concept," initially used for the 52-story One Shell Plaza Building in Houston.



*Fazlur R. Khan. Courtesy of Skidmore, Owings & Merrill LLP (SOM) and Stuart-Rogers.*

Khan's diagonal-framed tube system, first used for the John Hancock Center in Chicago, connected widely spaced exterior columns with diagonals on all four sides of the building. The concept allowed the 1965 Hancock building to reach 100 stories, making it the tallest building in the world. The Hancock Center and Khan's other masterpiece – the 110-story, 1974 Sears Tower with its unique "bundled tube" structural system – drew worldwide attention to the advancements that American structural engineers were making in skyscraper design. At 1,468 feet, Sears Tower remained the world's tallest building for more than 20 years. Clad in a black aluminum skin with bronze-tinted, glare-reducing glass and with a gross area of 4.4 million square feet, the structure was impressive and massive by any standards. Only the Pentagon had more space at the time.

Khan's portfolio of notable international structures includes the Haj Terminal Building at the Jeddah International Airport in Saudi Arabia, an enormous tent-like structure covering nearly one square kilometer (105 acres) of area, more space than any other roof in the world when built. Kahn allowed that the pioneering design of the terminal, with its

intricate fabric tension roof, was based on the union of architecture and engineering, form and function.

Zils said, "In addition to Faz being an innovator of the highest order as evidenced by his introduction to the profession of numerous innovative structural systems (tubular structural concept, tube-in-tube, braced tube, bundled tube, etc), he was the consummate team leader. You never worked for Faz, you always worked with him as an equal. Plus, his enthusiasm for whatever the task at hand or the project was contagious. His philosophy was that there was always something new and interesting about any task or project, and that it was up to us to find and pursue the issue."

Many times, Zils observed Faz getting involved in something that appeared on the surface to be quite mundane, only to find that in the end he had discovered something unique or interesting about it.

Said Zils, "I believe his ability to see the opportunities that each situation presents was a major factor in Faz's ability to think beyond the norm, and create and innovate as he did. Working on projects with Faz was always a joy because he was always probing and challenging the norm. He always did this in a collaborative way, incorporating the entire team in the process. As a result, you always felt a part of the process, and when the task or project was complete, all who participated felt some sense of ownership in the result." This collaboration, believed Zils, is why Khan was able to produce so many highly creative and innovative designs in his relatively short career.

*Onterie Center. The strength of the building's structural system is expressed in its facade. Courtesy of SOM.*

Active in several engineering groups, Khan was a leader in many of them. He was, for instance, chairman of the Council on Tall Buildings and Urban Habitat from 1979 until his death. He was also an adjunct professor at Illinois Institute of Technology (IIT), often teaching and working there late at night.

In addition to his participation in professional societies, and providing leadership and mentoring to young and up-and-coming engineers, Khan was active beyond engineering in his community. For many years, he served on the board of trustees for the condominium development in Chicago where he lived. And he never forgot his roots.

Khan's homeland came to be called Pakistan in 1947. During 1971, the country was divided into East Pakistan (now Bangladesh) and West Pakistan, with its government and military centralized in West Pakistan. Because of this, the economic conditions in East Pakistan (Khan's homeland) deteriorated so much that its people protested the unequal distribution of the country's income and wealth. To discourage unrest, the Pakistani government sent its military into East Pakistan to terrorize the people. Ten million Bangladeshi refugees eventually made their way to India.

As a result, Khan founded a Chicago-based organization, the Bangladesh Emergency Welfare Appeal, to help the people in his homeland. The group, which met at Khan's home, raised money for aid and for lobbying government officials. Many of the Bengalis involved (including Khan) had family and friends in Bangladesh who were in obvious danger; Khan's group did everything it could to make it safer for them. India's aggressive intervention finally put an end to the killing.

Fazlur's younger brother Zillur Khan said, "My brother was not only a creative structural engineer, he was also a philosopher, visionary, educator and humanist. As my guide, he always told me, 'Think logically and find the relationships which exist in every system, because it will help you understand nature itself, making living more meaningful and exciting.'"

Khan believed that engineers needed a broader perspective on life, saying, "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." Khan, himself, was an aficionado of classical music, especially Bach and Brahms. For enjoyment, he loved singing Tagore's poetic songs in Bengali with family and friends.

*John Hancock Center. Courtesy of SOM and Timothy Hursley.*

Khan and his wife, Liselotte, who emigrated from Austria, had one daughter, born in 1960. A structural engineer like her father, Yasmin Sabina Khan said of her father, "He was concerned, foremost, with people and how engineering affected them. He wanted his structures to be part of a culture and society that strove to benefit its people." In celebration of his life, she wrote an in-depth book about him and the impact of his work, *Engineering Architecture: The Vision of Fazlur R. Khan*, published in 2004.

Khan died of a heart attack while on a business trip in Jeddah, Saudi Arabia, on March 27, 1982. Only 53, he was a general partner in SOM, the only engineer holding that high position at the time. His body was returned

*Brunswick Building. Courtesy of SOM and Hube Henry-Hedrick Blessing*

*Khan (left) with SOM architect Bruce Graham and the John Hancock Center model. Courtesy of SOM and K&S PhotoGraphics.*

to the U.S. and is buried in his adopted home of Chicago.

Posthumously, the city of Chicago named the intersection of Franklin and Jackson Streets, located at the foot of the Sears Tower, "Fazlur R. Khan Way" in his honor. One year later, in 1999, *Engineering News-Record* listed him as one of the world's top 20 structural engineers of the last 125 years. Three decades earlier, when Khan was 41 years old, the Chicago Junior Chamber of Commerce had named him Chicagoan of the Year in Architecture and Engineering.

Among Khan's other honors were the Wason Medal (1971) and Alfred Lindau Award (1973) from the American Concrete Institute, Thomas Middlebrooks Award (1972) and Ernest Howard Award (1977) from ASCE, Alumni Honor Award (1972) from the University of Illinois, Kimbrough Medal (1973) from the American Institute of Steel Construction, Oscar Faber Medal (1973) from the Institution of Structural Engineers (UK), AIA Gold Medal for Distinguished Achievement (1983) and Aga Khan Award for Architecture (1983) from the American Institute of Architects, and John Parmer Award (1987) from the Structural Engineers Association of Illinois.

Khan was elected into the National Academy of Engineering in 1973, and received Honorary Doctorate Degrees from Northwestern University in 1973 and Lehigh University in 1980. In 2006, he was inducted into the Illinois Engineering Hall of Fame (sponsored by the Illinois Engineering Council).

His works and his citations are reflective of Khan's main legacy – more than any other individual, he helped usher in a renaissance in skyscraper construction in the U.S. during the second half of the 20th century. He epitomized both structural engineering achievement and the need for creative collaborative between architect and engineer. To him and his collaborators, for architectural design to reach its highest levels, it had to be solidly grounded in structural realities.▪

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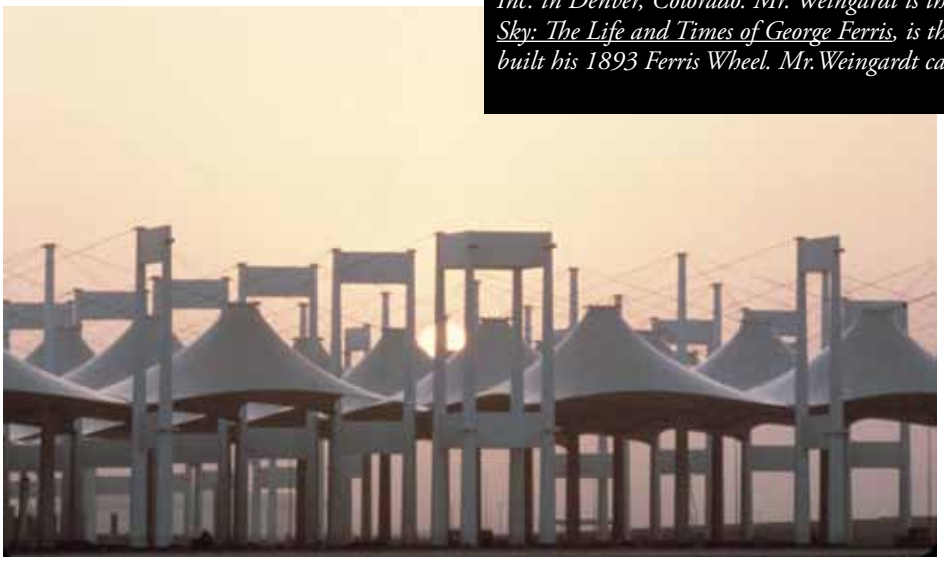

*Hajj Terminal. Courtesy of SOM and Jay Langlois of Owens-Corning Fiberglas.*