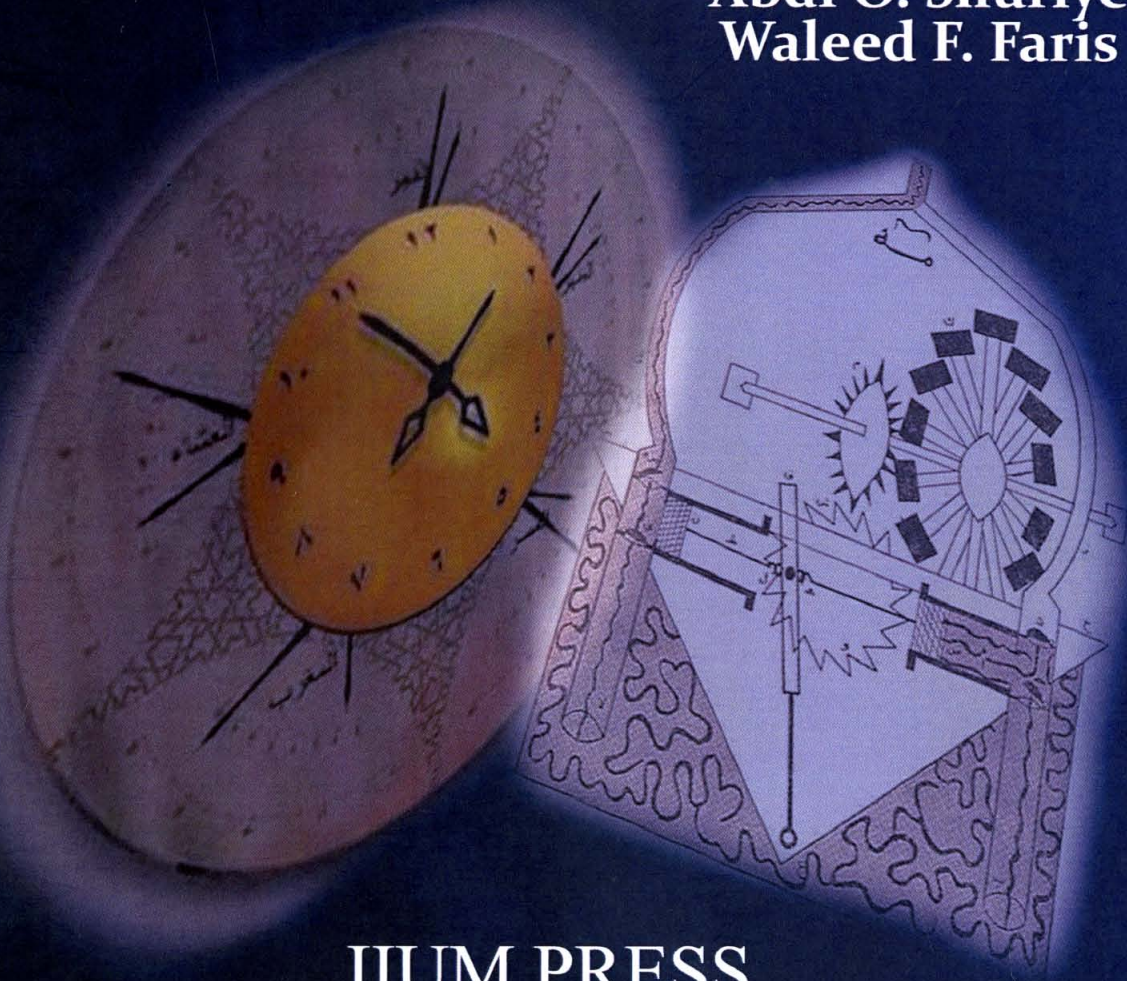


# Contributions of Early Muslim Scientists to Engineering Studies and Related Sciences

Abdi O. Shuriye  
Waleed F. Faris



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INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA





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## **Editors**

Abdi O. Shuriye  
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## **CHAPTER TWENTY TWO**

### **FAZLUR RAHMAN KHAN'S UNDERSTANDING OF TUBE STRUCTURAL SYSTEM OF SKYSCRAPERS**

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#### **22.1 INTRODUCTION**

The principal objective of this chapter is to discuss about contributions of Fazlur Rahman Khan, towards construction of skyscrapers. His innovations, namely framed tube, trussed tube and bundled tube, had led to significant improvement on structural efficiency and made the construction of tall buildings economically viable. The chapter will also investigate on the improvement of structural system using Khan's innovation and its impacts on construction of current generation skyscrapers. Research methodologies used are book referencing, internet searching and journals referencing. Fazlur Rahman Khan was a structural engineer, renowned for his designs of structural systems in the second half of the 20<sup>th</sup> century, which then remain fundamental to all skyscrapers todate. He was born in 1929, in Dhaka, Bengal now Bangladesh.

#### **22.2 EARLIER STRUCTURAL SYSTEM OF TALL BUILDING**

Reinforced concrete was discovered during the 18<sup>th</sup> and 19<sup>th</sup> centuries. Steel frames, which are stronger and lighter than iron, were widely used in early 20<sup>th</sup> century and made the construction of tall buildings possible. The first truly concrete skyscraper was 15-story Ingalls Building in Cincinnati, Ohio built in 1903 by A. O. Elzner. The building utilized a heavy monolithic beam-column framing system, two-way reinforced system of floor slabs, reinforced beams with bent bars near the supports and hoops, and continuous helixes in the columns to tie the vertical reinforcement together. Fabrications of the steel throughout the entire building for horizontal and vertical reinforcement were made from Ransome's square, cold-twisted reinforcing bar (Ali, 2001, p. 9).

In the first half of the 20<sup>th</sup> century, there was a rapid progress of technology in concrete construction, mostly in formwork, mixing of concrete, techniques for pumping, and types of admixtures to improve quality. These had further simplified the preparation of concrete in high-rise construction. Concrete building of more than 15-story buildings were rarely seen until about 1960 when tube structural system developed by Khan were introduced and then revolutionized construction of tall building (Ali, 2001, p. 3).

When Khan entered the profession as a structural engineer at SOM in 1961, the main structural systems known to designers were the beam-column frame and the shear wall or shear truss. These systems were effective for buildings up to 20 to 30 stories, but