



## **EDITORIAL: AN OVERVIEW ON HISTORY AND CURRENT STRATEGY OF STRUCTURAL ENGINEERING IN THE WORLD**

The history of structural engineering dates back to at least 2700 BC when the step pyramid for Pharaoh Djoser was built by Imhotep, the first engineer in history known by name. Pyramids were the most common major structures built by ancient civilizations because the structural form of a pyramid is inherently stable and can be almost infinitely scaled. Historic stone monuments in Parthia, Greek and Roman Empires confirm the existence of structural knowledge since 2000 to 500 BC, although the lack of written evidence makes it difficult to be sure of the design process in detail. Throughout ancient and medieval history most architectural design and construction was carried out by artisans. No theory of structures existed, and understanding of how structures stood up was extremely limited, and based almost entirely on empirical evidence of 'what had worked before'. Knowledge was retained by guilds and seldom supplanted by advances. Structures were repetitive, and increases in scale were incremental. No record exists of the first calculations of the strength of structural members or the behavior of structural material.

The physical sciences underlying structural engineering began to be understood in the mid eighteenth century. The traditional skills were presented with new challenges by the industrial revolution which required larger buildings to house larger and heavier machinery, as well as providing new materials in the form of cheaper cast iron, from the 1750s, and wrought iron, from the 1790s, and concrete, from about 1800. Cast iron was initially used for columns and small span beams, as well as bridges, its use becoming increasingly common around 1800. From the 1820s test results were being published and 'ideal' beam profiles were developed. Although steel was available from the 1860's it was not generally employed until the 1880's and even in the early twentieth century cast iron columns and wrought iron beams were still being used. Concrete was used in foundations from around 1810 in England, and then as backing for retaining walls. Concrete houses were built from the middle of the century, and various forms of reinforcement such as mining wire cables and iron sections used to provide reinforcement, but reinforced concrete as it would now be understood did not really come into widespread use until the 1890s, pioneered in France, Germany, and the United States. The idea of pre-stressed concrete was discussed before the First World War, but did not become a practical reality until the 1930s.

The challenge of new materials and ever larger structures was accompanied by increasingly sophisticated testing techniques and analytical methods, based on the work of Newton, Hooke, the Bernouillis, Euler and Coulomb through the eighteenth century, synthesized in the writings of Navier and Moseley in the early nineteenth century. From the mid nineteenth century methods of graphic analysis were employed, based on the teaching of Cuhlmann. The use of elastic methods of analysis was standard until the development of plastic analysis, notably by Baker between the world wars. While the potential of finite element analysis was recognized it was not a practical design tool until the arrival of computers in the 1960s. On the other hand, happening of some destructive earthquakes, such as San Francisco event in 1906 accelerated the development of structural engineering. Later on, earthquake engineering took shape from the mid twentieth century.

Structural engineering developed as a separate engineering discipline in the second half of the nineteenth century in response to the specialist requirements of the design of steel tall framed buildings and the introduction of reinforced concrete. It is traditionally viewed as an activity within civil engineering even though many other engineering disciplines such as aerospace, marine (naval, offshore), and mechanical engineering contain well established discipline specific structural systems components. In all of the various engineering disciplines there exists a large commonality in the structural materials used, in the general principles of structural mechanics, in the overall design philosophy and criteria, and in the modeling, analysis and computational tools employed for the numerical quantification and visualization of structural response. Developments in overall structural systems design are increasingly cross-disciplinary over many traditional engineering areas. Nowadays, advanced structural engineering has more emphasis on human safety, sustainability and environment compatibility. Structural engineers are looking for new cost-effective materials, as well as modern technologies in order to control the vibrations of structures. The highest level of know-how and expertise is employed to optimize the structural design and create innovative techniques for structural analysis and simplification of the tools.

In conclusion, with prospective safety and economic advantages, we as structural engineers have the opportunity to be involved in such progressed program and should participate in the future of structural engineering research.

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\* Some parts of this article have been selected from various texts in Wikipedia and other sources in internet and originally are not the author's opinion.