BOOK REVIEW

The History of the Theory of Structures: From Arch Analysis to Computational Mechanics

By Karl-Eugen Kurrer, Ernst & Sohn, 1–848 pp., ISBN: 978-3-433-01838-5, 2008.

The book presents a historical account of the development and evolution of structural analysis and design from the early days of empirical methods to the current era of structural and computational mechanics. Brief presentations of structural analysis methods are set in a historical background perspective. The book is the revised, extended, and updated version of a German edition published in 2002. It is divided into twelve chapters.

The first chapter serves as an introduction and gives an account of monographs published on the subject of the book. The conference on 'Historical perspectives and structural analysis', held in Madrid in 2005 constitutes the first major event on the history of structures.

The second chapter initially presents the major accomplishments of structural analysis during characteristic periods from 1575 to the current time. The discovery of the lever, the development of the principle of virtual displacement, the formulation of the equations of equilibrium, the definition of the stability and indeterminacy of structures, and the formulation of static system are outlined. The development of higher engineering education, which started in France in 1604 in specialised and military schools and the Ecole Polytechnique, and propagated in other countries including Austria, Germany and Russia and the United States is presented. Bridge construction in the second half of the nineteenth century at various characteristic structural systems and development of bridge engineering theories is described. The concepts of influence lines and the beam on elastic foundation, and the displacement, fictitious force and ultimate load methods of structural analysis are briefly presented. The chapter concludes with the introduction of spatial trusses used in modern structures.

The third chapter focuses on the philosophical aspects of the theory of engineering sciences, which brings together contributions from system theory, general knowledge, Marxism, history of engineering, engineering philosophy and engineering sociology, and its relation to engineering. Various philosophical views are presented and discussed.

The fourth chapter discusses the evolution of design based on the concept of the arch (masonry and elastic) for construction of bridges and vaulted structures from the ancient times to our days. Methods of analysis of masonry structures including classical static theories and finite elements are presented.

The fifth chapter presents the historical developments of the theory of structures and strength of materials from Leonardo da Vinci and Galileo, to Renaissance, to Navier, up to the end of the nineteenth century.

The sixth chapter puts emphasis in the so-called discipline-formation period of the theory of structures (1820–1900), which succeeded the preparatory period of structural theory. This period is divided into three phases: The Constitution phase (1825–1850) characterised by the formulation of the theory of structures and the bending theory by Navier, the Establishment phase (1850–1875) characterised by the development of theories of calculation of trusses and their replacement by graphical statics by Culmann, Rankine, Maxwell and Cremona, Lame, Clapeyron, Bow, and the Classical phase (1875–1900) characterised by completion of classical theories of structures by Maxwell, Winkler, Mohr, Castigliano, Muller-Breslau, Weyrauch, Rayleigh, Kirpichev, and others.

Chapter seven describes the developments in the so-called consolidation period of structural theory (1900–1950), which is characterised by the appearance of high-strength steels and welding as a new method of joining of structural parts. The Saint-Venant theory of torsion is presented, followed by Back's classical torsion tests, the theory of torsion of thin-wall sections, and buckling tests. Developments in the dynamic theory of structures, the composite steel-concrete construction in columns and beams, and lightweight steel constructions are presented.

Chapter eight presents the evolution in the conception, design, calculation, construction and production of spatial frame structures. The development of the theory of spatial trusses started during the last decade of the nineteenth century with the pioneering work of Föppl and continued during the consolidation period. Various types of dome designs and recent domed structures are presented.

Chapter nine presents the history of reinforced concrete structures starting with Lambot's reinforced concrete boat and Coignet's plan for a concrete house at the Paris World Exposition in 1855, and Monier's patent for the production of pipes and containers made of cement mortar with embedded iron. Christophe published the first authoritative work on the design of reinforced concrete structures in 1902. The evolution of reinforced concrete structures up to our era is presented. The chapter concludes with the fundamentals of the design and construction of prestressed concrete structures.

Chapter ten presents an overview of the historical evolution of the theory of structures from classical to modern. The displacement method of calculating structures in conjunction with the matrix theory laid down the foundations of computational mechanics. The advent of computers gave new impetus for the solution of linear and non-linear problems of structures. The chapter concludes with an account of the variation formulation of finite elements and the development of computational mechanics.

Chapter eleven discusses twelve scientific controversies which were raised during the history of structural analysis. It is based on a lecture the author gave to students of the Munich Technical University in 2004.

Finally, in chapter twelve the author discusses the relationship between structural design and aesthetics, and the contribution of computer-aided graphical analysis toward the aesthetic design. The chapter concludes with a proposal for incorporating a historic-genetic theory of structures in civil and architecture engineering curricula.

At the end the brief biographies of 175 renowned personalities in structural engineering are presented.

This unique book, written by an expert on the subject, presents an authoritative account of the history of the theory of structures. The author presents the historical developments with a critical spirit and philosophical perspective. The book is well written and organised. It is highly recommended to the engineer, the teacher, the scientist and the researcher who is interested in the historical developments of the evolution of the theory of structures.

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