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Book review

The History of the Theory of Structures: Searching for Equilibrium, 2nd edn.

K. E. Kurrer. Ernst & Sohn, Berlin, Germany, 2018, ISBN 978-3-433-03229-9, £120 (hardback), 1212 pp.

The first edition of the book appeared ten years ago and experienced very positive feedback from the engineering community. This was the impetus for the author to revise the first edition and to add new chapters. The general structure of the book was maintained.

The title of the book suggests that the reader will find a treatise on the history of various theories that are employed for the analysis of structures. While that is true, the book contains much more. Since the author is educated as structural engineer and beyond that, he studied history, the reader will find a deep examination of the underlying principles and at the same time, an informative reflection on the history and the protagonists involved. The book is not organised in a strict chronological manner; it is divided into thematic chapters that belong to certain periods but also touch on modern developments related to the theme.

The book starts with a contemplation about the tasks and aims of the historical study of the theory of structures and continues with 12 introductory essays on the various phases of development of the theory of structures. Subjects like preparatory phase (years 1575–1825), discipline-formation period (1825–1900), consolidation period (1900–1950), integration period (1950 to date) appear. The relevant chapters are further divided into several subchapters. Names like Galileo, Hooke, Bernoulli, Euler, later Navier, Culmann, Mohr, Cross and many others are named together with their respective achievements. The introductory essays also discuss the education of engineers in Austria, France, Germany, Russia and the US, the industrialisation of bridge-building and the ultimate-load theory and more. All subjects are exemplified by famous structures.

After this concise and chronological chapter, 12 more thematic chapters follow. The first of them is called 'The first fundamental engineering science disciplines: theory of structures and applied mechanics'. This chapter describes numerous attempts to define the meaning of engineering science in a fundamental and philosophical way. It cites also the most important textbooks in various countries. The next chapter, 'From masonry arch to elastic arch', starts with the description of bridges in Florence, Italy, and ends with the safety assessment of masonry bridges.

The following chapter is introduced in the second edition for the first time and is called 'The history of earth pressure theory'. After the first theories that were developed for military reasons, one can read about the inclined plane and lesser known names like Bullet, Gautier, Couplet, then about the wedge theory and the well-known Coulomb, about active and passive earth pressure, the contribution of continuum mechanics, the earth pressure as described by Terzhagi, Rendulic and Ohde, and finally the computer-assisted earth pressure calculations.

The next programmatic chapters are called 'The beginnings of a theory of structures' and 'The discipline-formation period of theory of structures'. One comes across the names of Navier, Claperon, Rankine, Maxwell and Lord Rayleigh. More materials-oriented chapters follow, such as 'From construction with iron to modern structural steel work' and 'Reinforced concrete's influence on theory of structures'. While steel is a homogeneous material with elastic-plastic behavior, concrete is inhomogenous, which asks for new ideas. Due to its low tensile strength, one has to take measures like steel reinforcement (starting with Monier) and prestressing, which has been invented by Freyssinet. Shear has been considered by Mörsch, supported by tests carried out by Leonhardt and handled by the concept of truss models of Schlaich. Shear is still a strong subject of debate.

The chapters 'The consolidation period of theory of structures' and 'The development and establishment of computational statics' enter the most recent eras of structural theories. The saying by Argyris 'The computer shapes the theory' is cited as an introduction to the finite-element method which has conquered all fields of mechanics and dynamics. People have expected wonders of this new calculation method and have blindly trusted in the calculation results before becoming aware that the physical experiment is still necessary, especially when nonlinear phenomena are involved.

'Thirteen scientific controversies in mechanics and theory of structures' close the chapters with established knowledge and lead to 'Perspectives for a historical theory of structures' with reflections on topics such as aesthetics, architecture, beauty and historico-generic teaching of theory of structures. The book closes with brief biographies of 260 protagonists of theory of structures from Airy to Zweiling, covering several centuries of continuous development.

Kurrer's book is a comprehensive treatise on the theories that are used for analysis and design of structures from the earliest days (Archimedes' lever principle) to the present (finite-element method). Those who have read the first edition of the book will be surprised by the huge amount of history and knowledge that has been added in the second edition. One can still read the individual chapters in isolation without losing the broad view on the total. The book is well illustrated with pictures, graphs, historical drawings and sketches, which makes for entertaining reading. It contains a wealth of information and is therefore a source for historians, especially interested in the history of technology, but also for professional engineers and graduate students of engineering and art history. The book is a necessary element of libraries and engineering departments.

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