Book review

Understanding Structural Engineering – from Theory to Practice

Wai-Fah Chen and Salah El-Din E. El-Metwally. CRC Press, Boca Raton, FL, USA, 2011, ISBN 978-1-4398-2710-9, £63.99, 272 pp.

This book presents the major advances in structural engineering concepts and design that have taken place over the last seven decades to reach the present state that is familiar to structural engineers. It also draws the attention of structural engineers to the drastic idealisation and simplifications for the equations of equilibrium, material behaviour and kinematics as well as structural systems.

The book is divided into seven chapters, including, in the introductory chapter, a brief overview of the theories that have been widely used in the actual design of practical structural engineering solutions. Chapters 2, 3 and 4 present several key achievements in concepts and simplifications in the elasticity, plasticity and finite-element approaches, respectively. These three chapters are essential to the understanding of the remaining chapters, which can be studied independently of one another. In chapter 2, the fundamentals of elasticity theory from a continuum mechanics point of view are first explained. The concept of generalised stress and generalised strain for various structural elements, such as bar, flexural, plate and shell elements, is then given to show how this technique can significantly reduce the number of system equations. Following the presentation of plasticity field equations and a few idealised yield criteria, the limit theorems of perfectly plastic material are described, in chapter 3. The plastic hinge analysis of steel structures and yield line theory of reinforced concrete slabs are both explained as upper-bound mechanism analyses. On the other hand, the strut-and-tie model is shown to be developed and based on the lower bound theorem of limit analysis. In chapter 4, the fundamentals of the finite-element method are described, along with how the finite-element method helped in modelling both material and geometrical non-linearities to simulate the actual behaviour of structures with great confidence.

The basic concept of the strut-and-tie model for the design of structural concrete discontinuity regions is illustrated in chapter 5. Selected strut-and-tie models for various D-regions, including dapped end beams, deep beams with and without openings, walls with openings, knee corner joints under opening or closing moments and interior and exterior beam-column connections are also covered. However, these selected models show strut elements in line format rather than actual sizes. There was also some overlapping and repeating of information presented in this chapter and chapter 3; for example, Figures 3-43 and 5-6 are identical. Chapter 6 presents the advancement in the second-order inelastic analysis for steel frame design. This chapter also introduces various simplifications for practical advanced analysis. With the exponential growth of computer speed and capacity, the authors expect that the model-based simulation and visualisation era will be the future key discipline for realistically simulating the behaviour of complex systems under loading and environmental conditions, and they describe this in the last chapter of the book. It is also briefly explained how the model-based simulation technique will enable a more thorough life-cycle exploration of design at a much lower cost.

All chapters are well written, complemented with a good number of examples and applications and well-presented figures. In addition, each of the main five theory chapters is concluded with a historical sketch, acknowledging the contribution of various scholars to the theory development and advancement presented in that chapter.

Overall, the book provides a big-picture guide to the key advances in structural engineering design, and the reviewer warmly recommends it to professional structural engineers and advanced structural engineering students alike.

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