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Book review

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Book review

Introduction to Earthquake Engineering

Hector Estrada and Luke S. Lee. CRC Press, Boca Raton, FL, USA, 2017,
ISBN 978-1-4987-5826-0, £76.99, 251 pp.

The authors of this book, both academics at the University of the Pacific in California, tap into the USA's rich history of seismic engineering to provide a concise introduction to the subject. Their book is aimed primarily at undergraduate and graduate levels, and thus it is of appropriate length, simply referencing other more informative texts on the same subject for necessary details (e.g. Chopra (2012) at 992 pages is referenced 17 times, and Villaverde (2009) at 960 pages is referenced ten times). The book's brevity gives it a particular worth, and hence engineers who are neither based in the USA nor in the early stages of their career will also find it useful.

Each chapter proceeds from simple to more complex systems, and when explaining a mathematical model or procedure, the authors always provide a practical example for greater clarity. These are in Imperial units, and many use Matlab routines to obtain quickly those calculation results that will be of most interest.

The book is divided into eight chapters, and successively they develop the relationship between seismology and vibration theory; basic structural dynamics; and codified seismic response guidance, in this case equivalent

static and dynamic structural analysis methods to ASCE 7 *Minimum Design Loads for Buildings and Other Structures*. Most complex non-linear analysis theory has been purposely avoided.

Chapter 1 describes the structural effects of earthquakes – namely, ground failure, indirect effects and ground shaking; the different types of earthquake – that is, man-made, volcanic and tectonic; and the historical development of earthquake-resistant design, which chronologically has occurred in five general stages. The ingenious masonry structures built by the Incas in Peru are perfect and fascinating examples of the first developmental stage.

Chapter 2 provides an overview of engineering seismology, with the characterisation and measurement of actual earthquakes possibly being of most interest.

Applied mathematics is used to describe the response of simplified structural systems to dynamic actions in Chapter 3. The transition from theory to practical systems begins in this long chapter – single-degree-of-freedom systems (SDOFs) are in due course translated into building frames, beams, water towers and bridges. Common types of lateral force-resisting systems, structural damping and time-dependent forcing, both at the centre of mass and at the structural support(s), are qualitatively and mathematically described.

Chapters 4 and 5 continue with SDOFs, and cover their response to general impulse loads, leading to the theory and development of response spectra, culminating in those used within current design codes. Chapter 6 studies the condensation of a multi-degree-of-freedom (MDOF) system into a generalised SDOF case which approximates to an overall mode of vibration.

The analysis of MDOFs is studied in Chapter 7, noting that although the first mode typically has the greatest influence on structural response, resonance can make other modes dominate at higher harmonics. The simultaneous modelling of all individual modes using matrix methods (i.e. modal analysis) is developed from the dependent fundamental equations of motion; and combination rules to obtain total response, such as the square root of the sum of the squares, are described. This chapter provides enough material for the student or practitioner to analyse a typical building frame which is subject to a characteristic earthquake event, and to determine its natural periods, mode shapes, peak displacements, maximum equivalent static floor forces, maximum base shear and maximum overturning moment.

Chapter 8 looks at the provisions of ASCE 7, and in particular those relating to modal response spectrum analysis, which are roughly based on the MDOF system analysis for shear buildings presented in Chapter 7. It also introduces the topic of linear time history analysis.

Technically, this book is admirable – the applied mathematics used to describe how structural systems respond to dynamic actions never fail to impress. The book's text and arrangement leads the reader step by step through a hugely complex subject, and the distillation of that subject into a relatively short work is equally impressive. Its potential wider readership outside the US student population ranges from the many engineers who are involved in the seismic qualification of structures and who wish to better understand the dynamic analysis software they regularly use, to those from other countries who are considering an extended professional assignment within the USA. The former will find it a handy aide-memoire to have on their bookshelf and the latter will find it simply invaluable.

Phillip G. Thurlow