Book review

Elements of stress analysis

Jacques Heyman, Cambridge University Press, Cambridge, 2008. ISBN 9780521730884, **£16.99, 116 pp.**

This book by Professor Jacques Heyman, former head of the Department of Engineering of Cambridge University, was first published in 1982 and is now also available in a paperback edition. It deals with topics which would typically appear in an advanced module of mechanics of materials in undergraduate courses of civil, structural and/or mechanical engineering. To quote the author from his preface

[this book] is not a text-book, in the sense that it does not deal exhaustively with any one topic. Rather, it discusses problems, in more or less detail, which arise in stress analysis . . .

At just over 100 pages, it does so in an elegant manner that should appeal to students, practising engineers and academics alike. The book consists of two main parts, respectively dealing with underlying theory (Chapters 1–5) and with the solution of a number of problems (Chapters 6–8).

The first four chapters deal with the concepts of stresses, strains and the constitutive relations between them. Elastic material behaviour is treated as well as plastic limits and the yield conditions of Tresca and von Mises. Furthermore, rotation rules for stresses and strains are derived and translated into the well-known Mohr's circles. In Chapter 5 the treatment of the fundamentals is completed by introducing the equations of equilibrium and compatibility. Together with the elastic relations between stresses and strains, this leads to the elastic equilibrium equations. Various formats of the elasticity equations are treated, which demonstrates how equations can be manipulated to suit certain applications. This chapter also provides introductions to the principle of virtual work and reciprocal

theorems, which are then used to give intuitively appealing explanations of the concepts of shear centre and influence lines.

In Chapter 6, a number of two-dimensional problems of elasticity are considered. Polynomial solutions for the two-dimensional stress state are constructed for pure bending, a cantilever beam subjected to a point load and a cantilever beam subjected to uniformly distributed loading. The treatise then moves on to an elastic half-plane, for which Fourier series are used to construct a solution. Chapter 7 first outlines the differences between standard engineering beam theory and the more general two-dimensional theory used in Chapter 6. This is followed by a straightforward derivation of expressions for the shear stress in beam bending. The concepts of shear centre and shear lag are discussed in detail. Finally, Chapter 8 deals with torsion. Solutions for thin-walled and solid cylinders are obtained directly from the elasticity equations. Next, the assumptions of de Saint-Venant are used to derive the harmonic equation for the warping function. The analogy of this equation with membranes (or sometimes known as the 'soap film analogy') is discussed, after which hollow sections and thin-walled open sections are treated. The chapter finishes with some observations on warping restraints and plastic torsion.

All advanced topics are based on fundamentals covered previously in the book. This makes the book self-contained and ideal for use by students in undergraduate courses, or as the starting point of relevant research projects.

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