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Book reviews

Control, optimisation and smart structures—high performance bridges and buildings of the future.

H. Adeli and A. Saleh. John Wiley & Sons, Chichester, 1999. ISBN 0 471 35094X, £51·95.

'Smart structures' is a seductive element in a 1999 book title, but it is necessary first to establish the sense in which it is used; in this case, the introduction of computer-controlled force actuators (jacks) to have a decisive influence on the response to dynamic loads. The structural tactics are simple to the point of brutality; 'design a predetermined number of members to be actively controlled ... each such member has an actuator'. The 'predetermined number' in the present examples tends to be large, for example 70 in the opening example of a simple truss highway bridge. Little indication is given of how this could be put into practical designs, the only diagram of an actuator installation being difficult to interpret. The reviewer's confidence is not increased by reading 'one actuator placed at one end of the member is usually sufficient, but when the force exertion capacity of one actuator is not enough, two actuators may be used, one at each end of the member'.

By this stage, the reader will be looking harder at the authors' credentials, and it is clear that this is a book by specialists in computation. The senior author has a major list of publications with titles typified by 'Neurocomputing for design automation' and 'Machine learning—neural networks, genetic algorithms and fuzzy systems', albeit his most recent title is 'Higher-performance computing in structural engineering' (GRC Press, 1999).

Following a very brief introduction to the problem (4 pages) and an overview of the chapter layout which is of similar length, there is a 120 page group of four chapters on the computational basis. This commences with a description of microtasking ('parallel processing at the loop level by inserting compiler directives ... without creating new concurrent algorithms') and its combination with macrotasking and autotasking in such a way as to achieve maximum performance, using a Cray YMP8E/128. The applications at this stage are various complex eigenvector problems, followed by solution of the Riccati control-optimization equation. The actual control and optimization principles whereby the linear quadratic regulator is applied to obtain an optimum gain matrix by minimizing a defined performance index, leading to the Riccati equation, are only briefly presented in the course of this development. The reviewer is not competent to assess the value of this half of the book, but it appears to follow a clear sequence, well presented.

The second half of the book comprises illustrative results for simple truss bridges and some multi-storey buildings. Loadings are proposed to represent the dynamic effects of earthquake, wind, traffic (for bridges) and blast (for buildings). The introduction of actuators into axial-force members has been mentioned above. It is not clear to the reviewer how the actuators are mobilized in the vierendeel-frame buildings, described as 'actuators and sensors collocated ... in the horizontal plane of the floor diaphragm alongside the beams'. Whereas the earthquake input is the classic 'El Centro' ground motion, the traffic and wind inputs are highly stylized deterministic sequences. The wind load, for example, is treated as the design-code wind force applied in a square-wave 'on–off' sequence of 5 seconds on, 5 seconds off. There is no discussion of the dynamic properties (frequency or damping) of the structure, this wind pattern produces no quasi-resonant build-up even in the absence of control, and there is no interpretation of the results in terms of an equivalent damping. Neither is there any consideration of the use of auxiliary masses.

This book needs a companion volume written by a structural designer. For the present, it will offer significant interest only to computational specialists—or to an author of the suggested companion volume who is prepared to invest much effort in the task.

T. A. Wyatt

Staircases—structural analysis and design.

M. Y. H. Bangash and T. Bangash. A.A. Balkema, 1999. ISBN 90 5410 6077, 337 pp.

The book covers a variety of forms and styles of staircase, from straight flights to cantilevers, spirals and helical forms with consideration of different methods of analysis both modern and traditional.

Examples of forms of analysis are collected from a wide variety of sources including those developed by Taleb, Gould, Leibenberg, Siev, Morgan and Cohen and include examples of flexibility, stiffness, finite element and plate/shell techniques.

In addition to the numerous examples of analysis, the book contains a variety of drawings and sketches from around the world with some detail of different material use.

The coordination of such a variety of forms of analysis with worked examples offers a good source of information for the comparison and research of analytical techniques and the subject

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chosen has considerable potential, which in the reviewer's opinion is not fully realized.

Your reviewer does not know, or know of, the authors and an introduction as part of the preface would have been useful in any assessment of content and assumption or possible users. The book will possibly 'serve as a useful text for teachers preparing design syllabuses for graduate and post-graduate courses' but the use of differing units, text and font could possibly confuse others seeking immediate information on the subject.

To be of value to a wider audience, perhaps the items on the list of definitions need to be increased and notations clearly explained. The diagrams used are not readily associated with the text and perhaps greater emphasis on the different design considerations for use of different materials is needed.

I. Stimson
(with acknowledgement to H. McConchie for assistance with the maths used)

Matrix structural analysis, 2nd edn.
W. McGuire, H. R. Gallagher and R. D. Ziemian. John Wiley & Sons, 2000. ISBN 0 471 129186.

This is the second edition of a text first published some 20 years ago that deals with the linear and non-linear analysis of frame structures subjected to static loading. When the book was first written, the topic was still comparatively new and the main need was to explain the underlying concepts and to present the theoretical development. Now that the topic is sufficiently mature that it forms an established part of all undergraduate and postgraduate structural teaching as well as being the basis for standard industry software, the emphasis has shifted somewhat. The challenge is no longer in presenting new concepts but in explaining both the basis and application of the method in a clear and relevant fashion. The importance of relevance arises because, while no user should be ignorant of the basis of the technique being employed, both students and practitioners are increasingly likely to have a greater interest in the intelligent application of standard programs, the writing and updating of such software being confined to specialists.

This text concentrates very much on presenting the underlying theoretical development; it contains little on the modelling of real structural forms. Moreover, it concentrates on bare frames, especially two-dimensional arrangements. Thus it does not deal with bridge decks and grillage analysis, interaction of the frame with cladding, shear walls, diaphragm action, floor systems and foundations, curved elements or cables or dynamic effects. Rather, it concentrates on a comprehensive presentation of the basic theory of the matrix stiffness method of structural analysis dealing with straightforward linear elastic problems and progressing to cover both material and geometrical non-linearity. It also contains chapters outlining solution procedures for both linear and non-linear analysis.

For readers whose interest does not extend beyond the underlying theory, this book provides a very clear and comprehensive coverage. Although it is American-oriented when dealing with structural sections and in its use of units, such material is sufficiently limited that the reader need not be distracted by it. Certain aspects of the approach to the analysis and design of unbraced steel frames according to North American practice are, however, a little more intrusive.

The book is very clearly produced, with worked examples, exercises and a generally easy-to-follow style. It is, however, competing with several other texts addressing the same subject material, as well as those chapters on the matrix stiffness method in more general structural analysis books. Overall, one is left with a feeling of some disappointment that the authors had not taken the opportunity of the new edition to rethink the emphasis and content and to include material on modelling at the expense of some of the more abstract theoretical coverage.

D. A. Nethercot

Analysis of engineering structures.
B. Bedenik and C. Besant. Horwood, 1999. ISBN 1 898 56355 1, £25.

This book is a well-written text aimed at students of civil and structural engineering courses. It covers, as one would expect, the basic theory of structures well in the early chapters. However, the analysis of structures has moved very rapidly following the development of computer technology. This has allowed engineers to explore structures that would have been impossible a few years ago. The geometry of some modern structures is so complex that without the application of computer analysis the concept would be impossible to construct.

A student studying structural analysis must come to terms with this. In order to do this he or she must first understand the basis of the analysis being applied. This means gaining a fundamental understanding of the process through simple hand calculations. Without this understanding the book correctly points out that there is a 'danger' of losing the 'physical feeling' of what the structure is doing in response to the application of loads. In order to address this the book uses well thought out worked examples to show the factors which are problematic and could be critical.

It does not matter if a real structure is simple or complex for the Health and Safety at Work Act, which demands that it is safe in use and is fit for the purpose for which that it was

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designed. Once the geometry of the framework and loading has been decided, structural analysis is the first stage in the process of creating a real structure. The second stage in the process is to use structural design to determine the member shapes and sizes. This latter part must be based on an understanding of the material properties and their behaviour under applied loads. It also demands a knowledge of the way that they are connected together to form the final structure. Without this understanding and knowledge it is still possible to recreate some of the recently spectacular 'computer-generated' structural failures that have occurred.

The book covers in reasonable detail the force method, the displacement method and the basis of the finite element method. It also gives a very limited introduction to inelastic behaviour 'plastic analysis' of structures. The book concludes by introducing the computer analysis of various structures. One of the examples is a simple bridge structure that has previously been analysed by hand and allows the reader to compare the results.

This book will be a great help to students in obtaining a clear understanding of structural analysis and the way basic structures behave when they are loaded.

F. E. Weare

Portland cement (2nd edition).
G. C. Bye. Thomas Telford, 1999. ISBN 0 7277 2766 4, £35, 224 pp.

In the preface to this book Dr Gerry Bye states that it is intended for use in ceramics and material science graduate courses, and that readers should have a grounding in physics and chemistry, ideally with an emphasis in phase equilibria and the kinetics of heterogeneous processes. Small wonder then that your reviewer found difficulty with certain parts of the book, even though he has had a long association with the cement industry, particularly the construction of new cement production facilities.

Dr Bye goes on in the preface to express the hope that a substantial part of the text will nevertheless be of value to science and engineering graduates entering (or presumably having a long-standing association with) the cement and concrete industries. It is from this standpoint that your reviewer undertook his task, and indeed found much of the remainder of the book more interesting.

Having outlined the history of cement from roman times to Joseph Aspdin and the present day, the author begins with a description of the chemical composition of Portland cement and the structure of cement clinker.

This is followed by an explanation of the range of the basic raw materials—chalk or limestone with clay or shale, and the physical properties and the proportions needed to produce Portland cement. This includes useful information on the preparation of the raw material and the addition of other raw materials which influence the properties of the finished cement.

In a world where commercial economics seem to dictate the almost universal use of the dry or semi-dry process, the author makes a point of describing all clinker production processes including semi-wet, and even the wet process, even though most examples of the latter have been consigned to history. Interesting though this is, a greater concentration on the dry and semi-dry processes, and an explanation setting out the reasons why they are now so widely used would be of value to many readers.

There follows a fairly basic chapter describing the tests used to test cement quality before the author takes the reader into a detailed explanation of the hydration process and the nature of hardened cement paste—of interest more to academics than engineers.

A useful feature of this, the second edition of this book, is the chapter which deals with cements related to Portland cement, including blended cements and cements containing fillers such as pulverized fuel ash.

This book will appeal mainly to those involved in research on the chemistry of Portland cement, both in its manufacture and use. It will have some appeal to civil engineers and others in the construction industry who wish to understand more about a material which many take for granted, but which is in effect one of the most useful and adaptable in the construction process.

R. D. Reith

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