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Book review

The Scaled Boundary Finite Element Method by J.P. Wolf, Wiley, Chichester, 2003, pp. xv + 361, price US$70.00 hardback, ISBN 0-471-48682-5

This is a postgraduate level book describing the basic concepts and applications of a novel numerical method recently developed by the author and his co-workers for the solution of a variety of linear problems governed by partial differential equations and involving elastostatics, elastodynamics and diffusion defined over bounded and unbounded domains.

The scaled boundary finite element method, described in the book, is a boundary element method based on finite elements, which tends to combine the advantages of both the boundary and finite element methods. More specifically, this new computational method is characterized by the following features:

(i) It is semi-analytical in the sense that it transforms the partial differential equation of the problem to an ordinary differential equation, which can be solved analytically. This is achieved by employing finite elements in the circumferential directions (parallel to the boundary) so that the resulting ordinary differential equation has the radial co-ordinate as independent variable. For a bounded domain this radial co-ordinate points from the boundary towards the interior, while for an unbounded domain from the boundary towards infinity.
(ii) Only the boundary of the domain is discretized, thereby reducing the spatial dimensions of the problem by one, as in boundary elements. However, no fundamental solution is required here and no singular integrals have to be computed, as in boundary elements.
(iii) The analytical solution in the radial direction permits the boundary conditions at infinity to be satisfied rigorously.

The book consists of two parts: Part I presents the basic concepts and derivations of the method by means of a model problem, that of the scalar wave equation in the two-dimensional domain of a wedge (bounded medium) and a truncated semi-infinite wedge (unbounded medium). In order to differentiate the method from either the boundary element or the finite element methods and at the same time demonstrate its common characteristics with both of them, a review of those two methods is also presented in this part together with standard fundamentals of numerical analysis. In Part II of the book, the fundamental equations and solution procedures are derived rigorously for the general case in great detail. Both the bounded and unbounded domain cases are considered for two- and three-dimensional problems in elastodynamics, statics and difussion. Both time and

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frequency domain formulations are described. At the end of this part a chapter on error estimation and adaptivity is also included.

More specifically, the book starts with a foreword by Professor J. Dominguez, an authority on boundary elements, a preface by the author himself and an introduction on numerical analysis in general (including boundary and finite elements) and on the new proposed method in particular. Then Part I and II of the book follow with 12 Chapters each covering all the aspects of the method as described previously. Both parts end with a comprehensive list of conclusions. At the end of Part I there are four appendices, while at the end of Part II there is a list of references and a subject index corresponding to all the chapters of the book. The book consists of over 360 pp.

In my opinion this is an exceptionally well-written book by an authority on computational mechanics who is very well known not only for his scientific articles but also for his excellent books. The concepts and derivations are analysed in depth and presented in an easy to understand way. The interrelations between the present method and the boundary and finite element methods are clearly stated. I also like two particular features of the book. The fact that the method is presented from two different viewpoints (the elementary in Part I and the rigorous in Part II) and the unified presentation of all methods through the vehicle of the method of weighted residuals. The only negative aspect of the book is that there are not many large-order numerical examples to illustrate the method and demonstrate its advantages and range of applicability. However, I fully understand that this is a new method still under development, especially in the area of applications. I am sure that the appearance of this book will certainly persuade many researchers to further develop this new and powerful method and apply it to more involved engineering problems.

I recommend this book as a postgraduate text to engineering students and as a valuable reference to researchers in mechanical, civil and aerospace engineering and numerical analysis in general. Needless to say all libraries should have this valuable book.

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