Int. J. Heat Mass Transfer. Vol. 27, No. 4, pp. 635–637, 1984
Pergamon Press Ltd. Printed in Great Britain

BOOK REVIEWS

C. A. BREBBIA (Editor), **Progress in Boundary Element Methods** (Volume 2). Pentech Press, London, 1983, 217 pp., £28.50.

THIS book represents Volume 2 of a series and is intended to bring together a new range of applications of Boundary Element Methods (BEM) that cannot be found anywhere else in current literature. It is a most welcome book, because of the rapid development of BEM and the great possibilities they offer for solving complex, non-linear and time-dependent engineering problems.

The book gives, in a text of 215 pages, well-presented contributions from various authors on different application aspects of BEM, as follows:

1. Non-linear potential problems by P. Skerget and C. A. Brebbia
2. Wave propagation phenomena by P. H. L. Groenenboom
3. Fracture mechanics stress analysis by C. Atkinson
4. Linear isotropic elasticity with body forces by D. Danson
5. The boundary element method applied to two-dimensional problems by T. Andersson and B. G. Allan-Persson
6. Boundary integral equations for bending of thin plates by M. Stern
7. Fluid-structure interaction by K. Komatsu
8. Viscoplasticity and creep using boundary elements by J. C. F. Telles and C. A. Brebbia.

The book closes with a subject index.

The first chapter deals with the solution of non-linear potential problems, for which the diffusivity is a function of the potential, and the boundary conditions are also non-linear. The solution involves the use of Kirchoff's transform to convert a non-linear material problem into a linear one. The text provides an adequate description of: (a) several shape functions to define the conductivity, (b) the type of integral equations that are obtained if the Kirchoff's transform is applied for non-linear material in the presence of mixed boundary conditions, and (c) the integral formulation for non-linear radiation boundary conditions. Several examples are presented as applications of the theory. They include a nuclear-reactor pressure vessel, a problem with several surfaces all exchanging heat by convection, and the cross-section of an industrial furnace. The method is claimed to be efficient and economic; a claim that cannot be verified by the reader since, unfortunately, no quantitative indications are given.

The second chapter is devoted to wave propagation phenomena, that are encountered in such engineering applications as antenna design, earthquake analysis, harbour design and piping networks. The purpose of this chapter is, as stated by the author, to demonstrate how the BEM can be applied to such phenomena, by establishing the fundamental relationships and by suggesting a numerical solution procedure. This purpose is adequately fulfilled in a text of 28 pages. The present reviewer found the physical problem discussed throughout this chapter very interesting indeed. This problem is the propagation of pressure waves in liquid sodium in a steam generator of a LMFB Reactor, as a consequence of violent sodium–water reaction, after the postulated rupture of a steam tube.

The problem of fracture mechanics is dealt with in the next chapter, which describes an improved implementation of the Boundary Integral Equation (BIE) and demonstrates its advantages. The text provides a special treatment of discontinuities associated with corners and points at which there is a discontinuity in the boundary condition. Three variants of the basic algorithm are introduced with modifications capable of accommodating boundary singularities. Attention is focused on two dimensions and, in particular, anti-plane strain (mode III) problems.

The chapter starts with the two features characterizing such problems, namely:

(a) "The indeterminacy encountered when ... the direct BIE formulation of a thin ellipse degenerates to a line", and
(b) "the existence of a stress singularity at a sharp crack tip which requires accurate boundary element modelling",

and it extends to 48 pages (the longest chapter in the volume), often simply collating substantial parts of the original sources (pp. 80–98) and including off-focus material (micropolar elasticity, coupled-time-dependent-thermoelasticity and thermoviscoelasticity), while omitting on-focus representative references [e.g. G. E. Blandford *et al.*, Two-dim SIF computation using the BEM, *Int. J. Num. Meth. Engng* **17**, 387–404 (1981)]. Furthermore, the author refers to the 'direct BIE' but does not comment on the 'indirect BIE'. Thus the reader is left to decide for himself whether problem (a) above is also present in the indirect BIE or not. This permeates throughout the chapter, causing some confusion, especially since much of the material presented in Sections 3.3.4–3.3.6 refers to the indirect or classical Integral Equations (not in the BIE/BE context).

It is in Section 3.3.6 where the author attempts to present a 'general formulation' as a remedy to problem (a). The present reviewer failed, however, to find such a formulation either in the direct or the indirect context, and was left only with the author's feelings and opinions, such as "... we feel it should even be possible to deal numerically with the improper integrals in eqn. 3.81 .... Failing this, of course, it should be possible to integrate by parts... there is nothing wrong with an integral equation based on eqn. 3.81 ...".

These comments aside, the chapter is a well-written and substantial contribution, and the modelling part which addresses problem (b) is a thorough and lucid presentation of various methods dealing with the crack tip singularity.

The fourth chapter deals with linear isotropic elasticity with body forces, probably the commonest type of analysis undertaken by engineers in practice. The author starts by examining the governing equations of elasticity and then shows how the Boundary Integral formulation follows directly from Maxwell-Betti's reciprocal theorem. The 2- and 3-D cases are then examined, and solutions at the boundary and internal points are obtained. This is certainly a text well thought through and this impression is carried well into the presentation.

Two-dimensional contact problems are discussed in Chapter 5. The basic concepts are outlined and two techniques for solving them with and without friction are presented together with interesting numerical results.

The formulation for plate bending problems is given in Chapter 6, together with some numerical examples, namely a uniformly loaded square plate under two sets of boundary conditions: hinged along the entire boundary or clamped on three edges and hinged on the fourth. An interesting Appendix is included, tabulating the basic functions associated with the singular displacement field at the base of a through crack, and the corresponding fundamental solution.

Chapter 7 considers the interaction between fluid and structure, describing the fluid in terms of BEM. In order to illustrate the application of the method described in the text, four examples are presented: the sloshing of fluid in rigid

containers, a double lobed tank, a hemispherical shell filled with liquid oxygen, and a spherical shell. In all cases, the results are shown to be in satisfactory agreement with exact solutions or experimental data. Finally, a BE formulation for the water impact problem developed by Geers *et al.* is presented. In this problem several formulations such as the MAC method and the FE method are available, and it is a pity that the author has not established conclusively his expectation that the BEM offers the opportunity to perform computations at reasonable cost, by comparing the CPU time requirements for these methods.

The last chapter, Chapter 8, is devoted to an application of BEM to viscoplasticity and creep. Three examples are considered: a simple supported deep beam under uniform load; a thin disc with a central rigid insert under constant external edge load; and a rectangular plate bonded on one edge to a rigid support and subjected to a sudden uniform temperature drop. The last example is particularly interesting since it demonstrates quantitatively that the BE results were obtained at less than half the CPU time required by a corresponding FE solution.

The text design quality is good and the book is very well printed and illustrated. The Editor did well to invite and collate all this interesting material in a single, handsome volume. The reviewer feels, however, that with slightly more editorial effort the styles of the presentations could have come closer together. Some inconsistencies and a certain incompleteness, as afore-mentioned, could have been eliminated and the book could have been a milestone in the development of the BEM. These small criticisms aside, the book can be thoroughly recommended to researchers in this field and to any practising engineer who is looking for new methods in solving his problems.

N. C. Markatos
Faculty of Science & Mathematics
School of Mathematics, Statistics and Computing
Thames Polytechnic, London SE18 6PF, U.K.

M. S. Sodha, S. S. Mathur and M. A. S. Malik, **Reviews of Renewable Energy Resources**. Vol. 1, Wiley Eastern Lim., New Delhi, 1983, 368 pp.

This is the first volume of a series, an effort supported by the UN University Fellowship Programme at the Centre of Energy Studies, Indian Institute of Technology (IITD) Delhi. This volume, as well as the announced second volume only deals with subjects related to thermal solar energy. Other renewables like wind energy are not (yet?) covered.

The five reviews in this volume compromise topics on work done at IITD, often in cooperation with other countries. This means that on the one hand specific details of systems are related to those developed in India, on the other hand the references give a very complete coverage of the literature of a particular topic.

The first review covers plastic solar collectors. This is quite appropriate because from a cost point of view they are attractive for developing, but also for developed, countries, the authors mention lifetime expectations of 1–9 years compared to 3–15 years for conventional collectors. Both for water and air heating collectors much information has been given. The second review discusses solar collectors with integrated storage systems. Again attractive for developing countries because of the simplicity of the system. Solar ponds, shallow water systems and collector-cum-ground storage units are discussed and the thermal system design given. The discussion of solar ponds is restricted compared to the other examples.

Solar hot water systems and their thermal modelling are given in a separate review. From basic radiation and heat transfer considerations as generally only found in textbooks, flat plate collector performance is derived. The practical applications considered are IITD systems and their performance. However, the equations have a general character and can be adapted for use in other systems.

Also solar absorption refrigeration and space conditioning are discussed. Only the ammonia–water cycle has been considered. This is surprising, because at the end of the review it is concluded that a single stage refrigeration cycle of this kind gives too low a C.O.P. for solar applications.

One wonders why the lithium-bromide cycle, which is much more attractive for solar air-conditioning, has not been discussed. The paper emphasizes the use of the ammonia–water cycle with the generator heated with solar energy as a heat pump for space heating.

However, much detailed information and many references are given on the thermodynamics and simulation of these systems, but few technical details on flows and conditions in an actual unit. The energy storage aspect is well covered and shown to be important.

Solar distillation is covered in the last review. Simple solar stills are reviewed. It is however, surprising that with the emphasis on topics related to developing countries this review is the shortest of the five. Especially so because the authors claim that this solar application is one of the most attractive on account of the fact that many tropical countries are in need of potable water. However, as a first introduction, with again a rather complete set of literature references this chapter will serve its purpose.

For this reviewer a drawback of many review books is that the topics covered are rather mixed and one's particular interest may go to only one or two of the topics covered. For those cases this volume gives a good review of the state of the art and refers rather completely to original papers. For a more general purpose in education the diversity of topics covered could restrict its use. For research and development institutes and groups working on thermal solar energy these reviews give important and useful information.

C. J. Hoogendoorn
Technische Hogeschool Delft
Laboratorium voor Technische Natuurkunde
Postbus 5046
2600 *GA*
Delft
The Netherlands

J. Taborek, G. F. Hewitt and N. Afgan, **Heat Exchangers: Theory and Practice**. Hemisphere, Washington, DC, 1983, 992 pp., $69.96.

This is a bound volume of eleven invited lectures and 30 papers by some 80 authors, selected from 70 papers presented at the 1981 Seminar of the International Centre for Heat and Mass Transfer. It is hardly, as the title suggests, a book on the subject.

The notice inside the paper cover says it is "an authoritative volume providing up-to-date information on the complete spectrum of heat exchanger application in industry" which is rather too much for the editors to claim. The up-to-datedness is not in question, but the volume is largely uncoordinated and is far from a complete 'spectrum' whatever the word means. The papers frequently lack comparisons with other published data, for example, on the widely important subjects of heat transfer and pressure drop in tube bundles the four papers, two from U.S.S.R. and two from Germany, refer scantily to other work; one paper has no references.

In these respects, the volume cannot be compared with the recent *Heat Exchanger Design Handbook* also published by Hemisphere, which is a more comprehensive, logically set out account of the subject.