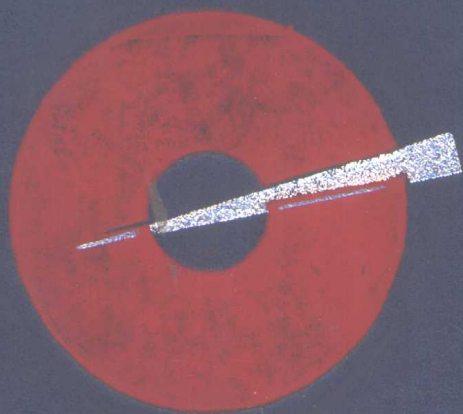




有限元法手册

H. 卡德斯图赛 主编

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诸德超 傅子智 等译

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内 容 简 介

本手册共分四篇,其内容覆盖有限元法的各个方面,具体包括有限元法的数学提法,基础知识,实际应用以及计算细节。

本手册基本概念清晰,应用性强,附有大量参考文献,可供有关的科学、技术工作者及大专院校师生阅读、参考。

Finite Element Handbook

H. Kardestuncer, Editor-in-Chief

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有限元法手册

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主 编: H. KARDESTUNCER

执行编辑: D. H. NORRIE

分篇编委: F. BREZZI, S. N. ATLURI,

D. H. NORRIE, W. D. PILKEY

名誉编委: J. H. ARGYRIS, J. T. ODEN,

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中 译 本 序

有限元法作为一种数值分析方法,其萌芽可追溯到18世纪的Euler. 然而,只是在电子计算机开始普及使用后,它才真正受到人们的重视,并以令人惊讶的速度迅速发展,至今已成为计算力学在本世纪最重要和最辉煌发展的一个方面. 在实践上,从50年代中期飞机薄壁结构分析的初期应用开始,至今已扩展到几乎所有的科学技术领域,对推动当代科学技术和工程实践的发展,已起到并将继续发挥难以估量的作用. 本书原序中谈及,“在80年代初期,全世界已有2万个以上的有限元用户,年耗资达5亿美元左右,其后还在不断迅速增长.”(大意)其规模之大,影响之深,由此可见一斑.

鉴于此,McGraw-Hill 图书公司于1987年出版了这本《有限元手册》. 本书由H. Kardestuncer 博士主编,邀请96位在本行业有卓越贡献的专家撰写,费时达6年以上.

本手册简练扼要地介绍有限元法理论和实践的精髓. 在内容上包括有限元法的基本数学原理、基本数学表示法、应用以及计算技术和有关的软硬件系统. 在学科应用上则涉及固体力学、流体力学、地质力学、空气力学、生物力学、化学反应、核反应堆、等离子体、声学、电磁学等. 在有限元领域内,它不愧是一本博大精深的极为宝贵的工具书. 它既可作为研究工作者的参考书和原典,也可为实践工程师提供指南,它是有关专业教师、研究生和高年级学生的必备用书.

我们在1988年看到了本书,翻阅之下不禁产生了翻译出版以飨广大中国读者的想法. 这个想法立即得到科学出版社的大力支持. 因此,我们组织了一个小组着手工作,参加翻译的同志有诸德超、傅子智、胡建、崔俊芝、龚尧南、张炳暄、张承煦、王大钧、武

际可。其具体分工如下：第一篇各章由胡建、崔俊芝译；第二篇第一、二、六章由龚尧南译，第三、四、五章由傅子智译；第二篇第七、八、九章及第三篇第一、五、八章由诸德超译；第三篇第二、四章由张炳暄译，第六、七章由张承煦译，第三章由张承煦、张炳暄译；第四篇第一、二章由王大钩译，第三、四、五章由武际可译。张纪刚同志对译稿作了技术校对，李成香同志作了认真细致的编辑加工，一并致谢。本书内容广博，技术难度大，在任务重时间短的情况下，我们虽然作了许多努力，差错恐怕仍所难免。尚祈读者不吝指正，将不胜感激。

诸德超 谨启
傅子智

1992.7

作者一览表

Abel, J. F. Professor of Civil Engineering, Department of Structural Engineering and Program of Computer Graphics, Cornell University, Ithaca, New York
(PART 4) CHAPTER 4: 4.3 *Interactive Computer Graphics for CAD/CAM*

Akay, H. U. Professor of Mechanical Engineering, Purdue University, School of Engineering and Technology at Indianapolis, Indianapolis, Indiana
(PART 3) CHAPTER 4: 4.6 *Transonic Flow and Shock Waves: Combined Shock Capturing and Shock Fitting*

Allik, H. BBN Laboratories Incorporated, New London, Connecticut
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Astley, R. J. Senior Lecturer in Mechanical Engineering, University of Canterbury, Christchurch, New Zealand
(PART 3) CHAPTER 7: 7.4 *Acoustics*

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Brebbia, C. Computational Mechanics Institute and University of Southampton, Southampton, England
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Bristeau, M. O. INRIA, Le Chesnay, France

(PART 3) CHAPTER 4: *4.3 Transonic Flow and Shock Waves: Least-Squares and Conjugate-Gradient Methods*

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Editor of CHAPTER 4 in PART 3

Ciarlet, P. G. Professor, Analyse Numérique, Université Pierre et Marie Curie, Paris, France

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Pironneau, O. Laboratoire d'Analyse Numérique, Université Pierre et Marie Curie, Paris, France

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Pittman, J. F. T. Department of Chemical Engineering, University College of Swansea, University of Wales, Swansea, Wales

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(PART 3) CHAPTER 1: *1.7 Finite-Element Analysis of Projectile Impact Response*

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(PART 3) CHAPTER 6: *6.7 Blood Flow*

Smith, R. M. Central Electricity Generating Board, Berkeley Nuclear Laboratories, Berkeley, Gloucestershire, England

(PART 3) CHAPTER 2: *2.9 Turbulent Flow*

Storaasli, O. O. Structures and Dynamics Division, NASA Langley Research Center, Hampton, Virginia

(PART 4) CHAPTER 4: *4.1 Modern Computing Systems, 4.2 Algorithms and Software Development*

Stronge, W. J. Lecturer, Engineering Department, University of Cambridge, Cambridge, England

(PART 3) CHAPTER 1: *1.7 Finite-Element Analysis of Projectile Impact Response*

Surana, K. S. Associate Professor, Department of Mechanical Engineering, The University of Kansas, Lawrence, Kansas

(PART 2) CHAPTER 4: *4.3 Isoparametric Finite Elements*

Szabo, B. A. Professor, Albert P. and Blanche Y. Greensfelder Professor of Mechanics, Director, Center for Computational Mechanics, Washington University, St. Louis, Missouri

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Taylor, C. Professor, University College of Swansea, University of Wales, Swansea, Wales

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Editor of CHAPTER 2 in PART 3

Thomas, C. E. University College of Swansea, University of Wales, Swansea, Wales

(PART 3) CHAPTER 2: *2.10 Turbulent Heat Transfer*

Thomé, V. Professor, Department of Mathematics, Chalmers University of Technology, Göteborg, Sweden

(PART 1) CHAPTER 6: *Finite-Element Methods for Time-Dependent Problems*

Tong, P. Chief, Structures and Dynamics Division, Transportation Systems Center, U.S. Department of Transportation, Cambridge, Massachusetts

(PART 2) CHAPTER 5: *Mixed and Hybrid Finite-Element Methods*

Utku, S. Professor of Civil Engineering and Professor of Computer Science, Duke University, Durham, North Carolina

(PART 3) CHAPTER 8: *8.1 Solution Errors in Finite-Element Analysis, 8.2 Principles for Design of Finite-Element Meshes*

Editor of CHAPTER 8 and Principal Author of Section 8.1 in PART 3

Wachspress, E. L. Professor, Department of Mathematics, The University of Tennessee,
Knoxville, Tennessee

(PART 2) CHAPTER 6: *6.3 Rational Finite Elements*

Whiteman, J. R. Professor, Institute of Computational Mathematics, Brunel University,
Uxbridge, Middlesex, England

(PART 2) CHAPTER 6: *6.1 Finite-Element Method with Singularities*

Wood, W. L. Department of Mathematics, University of Reading, Reading, England

(PART 2) CHAPTER 8: *Transient Response Analysis*

Zienkiewicz, O. C. Director, Institute for Numerical Methods in Engineering, University
College of Swansea, University of Wales, Swansea, Wales

(PART 2) CHAPTER 8: *Transient Response Analysis*

序 言

有限元法是计算力学在本世纪最重要的发展之一。仅仅在几十年内，这种技术已从结构工程中的初期应用演化成许多科学和技术领域内广泛应用和丰富多采的计算方法。在 80 年代初期，全世界已有 2 万个以上的有限元用户，估计他们每年在有限元分析上耗资达 5 亿美元左右。从那时以来，在用户和应用范围两方面的数目都在继续不断地迅速增长。

本手册的目的是在一卷书内介绍有限元法的基本数学原理、基本数学表示法以及普通和专门这两方面的应用。它是对截止到出版时已有的有限元理论和实践的最为广博的纵览。

《有限元手册》分为四篇，其内容是相互关联的。第一篇提供有限元法的当代数学背景。第二篇探讨方法的基本法则。第三篇论及应用，是篇幅最大的一篇。第四篇研究方法的计算方面。各篇中的具体各个章节由学术界和工程界的 96 位对某一领域有显著贡献的特邀作者撰写。在“作者一览表”部分（按姓氏的字母顺序）列出了作者的姓名、所在单位以及他们各自撰写的部分。

手册的第一篇从研究泛函分析、泛函空间和偏微分方程开始，来建立有限元法的数学基础。然后是仿射等价或几乎仿射等价的有限元的简洁而精巧的理论。这个理论已被证明是一个有高度价值的工具，用于例如等参和曲边元、奇异和有理元、组合元、数值积分和非协调方法等领域内的数值分析。后面各章处理关于椭圆边值问题、特征值问题和随时间而变的问题等的有限元法。最后一章叙述用于变分不等式的有限元法。

第二篇首先评述变分原理和本构方程。然后介绍变分有限元法的基本步骤——从开始的离散化和单元选择到系统矩阵方程的求解。接着是详细处理以位移场为基础的有限元以及叙述混合和

杂交有限元法。然后通过其它型式的有限元法而转向评述失稳分析和瞬态响应分析的有限元法。最后一章汇总了有关误差估计、收敛率和稳定性的重要知识。

第三篇叙述了有限元法在固体力学、流体力学、地质力学、空气力学、生物力学、化学反应、核反应堆、等离子体、声学 and 电磁学中的广泛应用。在不同程度上对包括流体、结构和土壤的耦合系统也进行了研究。最后和十分重要的一章是评估有限元计算中的误差以及斟酌选用网格设计对策的原则。

第四篇从评述求解有限元分析中系统矩阵方程的技术开始，然后研究重分析、模态综合、静力凝聚和子结构法。紧接着的论题是模型化、前处理和后处理。然后是评估在刚刚过去和不久的将来中计算机技术的新方向并联系到有限元硬件和软件系统的预期发展。最后一章是对有限元软件包的当前能力作出纵览。

预期《有限元手册》对于科学界和技术界的许多专业集团将会成为一本有价值的参考书和原始资料集。从事实际工作的专业工程师可从本手册得到关于下列问题的指南和说明，这些问题是：

- 有限元可用于哪些问题？
- 一个特定类型的问题适合于用哪一种数学表示法？
- 对于系统矩阵方程应该使用什么算法？
- 对于一个给定的问题最适合于用哪一种单元？
- 优良网格设计的原则是哪些？
- 合乎需要的前处理和后处理应达到什么程度？
- 有没有现存的软件包能够满足一个特定的需求？

以其在理论和实践上广泛的覆盖范围和每章末尾列出的广泛的参考文献目录，学术界、工程界和政府部门的研究者以及对基本原则比对应用更感兴趣的研究者将会发现本手册是一本最为有用的原始资料集。在前面几章中有限元法的数学基础将使应用数学家和其他理论研究者感到兴趣。本手册不仅把取自许多现有教科书、专著、学位论文、研究报告、论文、会议文集和期刊文章的关于有限元法的精髓汇集在一卷书中，而且还包括有以前

尚未发表过的原始资料。

虽然已经十分仔细地排除本书中的差错，但不可避免地还会留下一些。如果能把所发现的任何差错通知出版者以便能在以后的印刷品中排除它们，作者将十分感谢。

本书的出版是来自全世界许多地方的一百多人通力合作的结果。我们衷心希望，本著作将不仅对那些在有限元方面有兴趣的人是有价值的，并且希望，至少在某种程度上，对繁荣全人类也有所贡献。

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