

西安交通大学学术专著丛书



强度理论 新体系

俞茂铨 著

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Xi' an Jiaotong University Series

New System of Strength Theory

Yu Maohong

Xi' an Jiaotong University Press

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作者简介



俞茂铨(铨亦作宏),原籍浙江宁波,1934年11月生于江苏镇江。1955年浙江大学本科毕业,历任西安交通大学助教、讲师、副教授和教授,现任建工系结构研究室主任,并兼任国家教育委员会工科力学课程教学指导委员会委员。

俞茂宏长期从事材料力学、结构力学、弹塑性力学以及结构强度和振动的教学和科研工作。他的主要科研成就为:(1)创立双剪强度理论,形成了强度理论新体系。著名科

学家、中国科学院学部委员周惠久教授曾评论：“由俞茂宏同志经过 30 年研究创立并发展的双剪强度理论是剪切强度理论一个新的突破”，“它不但具有重要的理论价值，而且具有指导工程实践的经济意义，其发展可望成为由我国科学家创立的一个系统的第五强度理论，进入国际学术的先进行列”。(2)提出集中质量消振法，创造性地消除了多台大型发电机的剧烈电磁振动，取得了巨大的经济效益，得到上海市经委和水电部的高度评价。(3)采用现代科学方法对西安地区的古建筑结构进行了多方面的系统研究，被国家文物局认为具有开创性意义。他的 60 余篇论文分别发表于《金属学报》、《中国科学》、《科学通报》、《Int. J. of Mech. Sci》、《土木工程学报》、《力学学报》、《日本土木学会构造工学论文集》、《中国电机工程学报》、《岩土工程学报》等国内外期刊和学术会议论文集。其中四项被国家科学技术委员会确认为国家级重大科技成果。

1990 年和 1991 年俞茂宏教授被英国剑桥传记中心和美国传记研究所选入：“Men of Achievement (A Guide to the World's Influential Men)”，“The International Who's Who of Intellectuals”，“Men and Women of Distinction: A Fully Illustrated Record of Notable Achievement”，“Dictionary of International Biography”，“5000 Personalities of World”等世界人名录。

(照片系 1961 年时的作者，是年作者 27 岁，任西安交通大学数理力学系讲师，并首次提出了双剪应力屈服准则和十二边形加权双剪应力屈服准则。)

A BRIEF INTRODUCTION TO THE AUTHOR

Yu Maohong was born in November 1934 in Jiangsu Province, China. He is a professor of Xi'an Jiaotong University, a member of the Committee of Mechanics Courses under the State Education Commission of China. After graduated from Zhejiang University in the summer of 1955, he worked for long years on teaching and research of the mechanics of materials, plasticity, structural mechanics, strength and vibration of structures et al in Xi'an Jiaotong University.

Yu's contributions to science and technology are:

(1) Foundation of the theoretical system of Generalized Twin Shear Strength Theory and Twin Shear Theory, including the twin shear stress state theory, twin shear yield criterion, twin shear strength theory, twin shear elasto-plastic constitutive model, twin shear slip lines field theory, et al. Twin Shear Theory is considered a new important advance since the single shear theory of Tresca (1864)-Mohr (1882)-Coulomb (1773)-Schmid (1924).

(2) Proposal of the vibration suppression method with concentrated mass which has been successfully applied to several large turbogenerators. The severe stator vibration of these turbogenerators were found to be reduced and huge economical profits were attained.

(3) Researches on the preservation of Xian's ancient architectures. These researches are approved as a creative work by the State Administration Bureau of Museums and Archaeological Data of China.

Yu's works include "Macroscopic Strength Theory", "Mechanics of Materials", "Researches on the Twin Shear Stress Strength Theory", "Advances in the Researches of Twin Shear Strength Theory", "New

System of Strength Theory”, “Researches on the Ancient City Walls of Xian”. His papers entitled “Twin Shear Stress Yield Criterion”, “Twin Shear Strength Theory and Its Generalization”, “A New model and New Theoretical System of Yield and Failure of Materials under the Complex Stress State”, “Magnetic Vibration of Large Turbo-generator Stator and Its Suppression” and other some sixty papers were published in Int. J. of Mech. Sci., Scientia Sinica (Science in China), Acta Metal. Sinica, China Civil Engineering Journal, Acta Mechanica Sinica et al. and Proceedings of CIGRE (Paris), TEPCON (Tehran), ICSF (Singapore), ICM-6(Kyoto). PLASTICITY '89 et al.

Yu's name and biography is included in “The International Who's Who of Intellectuals”(9th Ed.), “Men of Achievement”(15th Ed.), “Dictionary of International Biography”(22nd Ed.), “Men and Women of Distinction; A Fully Illustrated Record of Notable Achievement”(Fourth World Ed.) of IBC and “5000 Personalities of the World”(3rd Ed.) of ABI and others.

Yu has been awarded eight prizes of first degree by Shaanxi Province, Xi'an Jiaotong University and Higher Education Bureau of Shaanxi Province for his scientific researches, in which four were approved the National Important Achievement by State Scientific and Technical Commission of China, the highest prize of Li-Xun Foundation of the Chinese Society of Metal, the second prize for Advancing in Science and Technology of Shaanxi Province, the First Prize of Excellent Paper of Shaanxi Province, and some other high grade awards. He is elected as the Distinguished Person of Scientific Research by Xi'an Jiaotong University. His research group “Strength Theory and Its Application” is elected as the Distinguished Research Group by Xi'an Jiaotong University recently.

“西安交通大学学术专著丛书”出版说明

“西安交通大学学术专著丛书”是“西安交通大学学术专著出版基金委员会”支持的学术著作系列书。

“西安交通大学学术专著丛书”是为我校教师和海内外校友出版学术专著而设立的。它对学术专著的要求是：内容的主题必须是著作者本人或合作者的研究成果，具有鲜明的特色和独特的见解或方法，推进或补充了前人在某学科领域的创造，达到国内外先进水平。投来的书稿由基金委员会聘请校内外学者、教授、专家若干人认真评审，复经基金委员会（由校长聘请若干名教授组成）严肃讨论并最后采取无记名投票方式裁定。

学术著作的水平，是一个国家、一个民族科学文化水平的标志之一。它不仅代表了一定的学术文化水平和理论深度，而且其中蕴

含着丰富的潜在生产力。“西安交通大学学术专著丛书”是反映我校较高学术水平和科研水平的一个窗口,也是我国学术海洋的一朵浪花。涓涓的细流汇入浩瀚大海,让我们为伟大祖国的学术繁荣,四个现代化的突飞猛进共同努力吧!

A PUBLICATION DESCRIPTION OF ACADEMIC WRITING SERIES OF XI' AN JIAOTONG UNIVERSITY

“Xi' an Jiaotong University Series” is a set of academic writings supported by a publication fund from Xi' an Jiaotong University.

“Xi' an Jiaotong University Series” is intended to publish academic writings of teaching staff and alumni both at home and abroad. It is required that the writings to be published should be individuals' or co-partners' scientific investigations and research results with obvious peculiarities, originative viewpoints and methods, which may enhance and supplement predecessors' creativeness in some field, and which have reached national or world advanced levels. Any manuscript sent to the University Press will first be conscientiously evaluated by scholars, professors and experts inside and outside the university, who are invited by the Fund Commission. Then, it will be re-examined strictly by the Fund Commission itself which is made up of a few distinguished professors appointed by the president. And finally, whether the manuscript may be published or not will be decided by ballot.

The merit of technical writings signifies one of the scientific and cultural levels of a country and of a nation. It is not only the sign of a

certain level of technical culture but also theory in depth, and it embodies abundant potentialities of the productive forces as well. “Xi'an Jiaotong University Series” may serve as a window from which to get a glimpse of the excellences of higher academic and scientific researches taking place at our university. It also reflects that “Xi'an Jiaotong University Series” seems to be like a tiny drop of water in waves that flows into vast oceans of millions of books published all over China . We are now striving for academic prosperity in our great country and making efforts to stride with rapid steps in the four moderizations.

内容简介

强度理论是判断材料在复杂应力状态下是否破坏的理论。它在材料力学、塑性力学、金属压力加工、机械设计、岩土力学、结构塑性分析以及各类工程结构和机器强度设计中有着广泛的应用。

本书系统地总结了作者 30 年来有关强度理论的研究成果,并建立了统一的强度理论新体系。这一体系从一个统一的双剪模型出发,推导得出了一个统一的强度理论数学表达式,它包含了作者提出的双剪应力强度理论、双剪应力屈服准则和两族加权双剪强度理论,以及国外学者提出的一些主要强度理论。书中还介绍了双剪弹塑性有限元程序及其应用实例。该程序包括了统一强度理论所包含的 14 种计算准则,可适用于范围较宽的各类材料。

本书对象为高等院校、科学研究、勘测、设计、制造等工程技术部门从事材料强度和结构强度研究、设计和应用的教师、科学研究和工程技术人员以及研究生和大学生。

A BRIEF INTRODUCTION TO THE BOOK

Strength theories or failure criteria are concerned with the theory of yield and failure of materials under the complex stress state. It is very important for both theory and application of mechanics of materials, plasticity, mechanics of soil and rock, plastic analysis of structures, metal forming processes, design of machine and many fields of engineering.

The systematical results of the author's researches in strength theory are summed up in this book. Based on the twin shear stress model, a unified mathematical equation of strength theory is given, and a theoretical system of the unified strength theory, i. e. generalized twin shear stress strength theory, is established. This unified strength theory includes the twin shear yield criterion, twin shear strength theory, two families of weighted twin shear criteria and the Tresca, Mohr-Coulomb theories. The twin shear elasto-plastic finite element program and two examples of application of this program are introduced, in which the fourteen criteria of unified strength theory are included. They may be adapted for all kinds of isotropic materials.

This book can be used by the researchers, engineers, teachers, graduates and advanced undergraduates in universities, research institutes, investigation and design institutes, and many fields of engineering for research, design and application on the strength of materials and structures.

前 言

强度理论研究材料在复杂应力状态下产生屈服和破坏的规律。它为各类工程结构和机器的强度设计提供计算准则；同时它也是材料力学、塑性力学、岩石力学、土力学、金属压力加工原理、机械零件设计、结构塑性分析、飞机结构强度、钢筋混凝土结构理论以及各种工程结构强度计算所需的基础理论；此外选用合理、先进的强度理论，还能取得巨大的经济效益。因此强度理论的研究在理论上、工程实际中和经济效益上都具有重要意义。

作者从 1959 年开始研究强度理论，1961 年提出双剪应力屈服准则和十二边形加权双剪应力屈服准则。此后逐步发展形成一个统一的广义双剪强度理论新体系。它从一个统一的模型出发，推

导得出一个统一的数学表述式,由此可得出现有的一些主要强度理论和各种可能的强度理论,成为一个统一的强度理论。强度理论的统一,曾经是 50 年代至 60 年代由联合强度理论所引起的、人们多年努力而未能实现的一种期望,这是作者当年未敢奢望的,现在也只是在前人工作基础上的一个初步总结。

双剪强度理论的各个阶段的研究结果曾经发表于《科学通报》、《金属学报》、《Int. J. Mech. Sci.》、《中国科学》、《土木工程学报》、《力学学报》等国内外著名期刊,本书为它们的系统总结。本书著述两年,修改三次。在此书交稿之时,出版社囑写前言一篇,要求阐明这一研究的创新性、长期性和系统性的特色,拙笔难尽,它们只能以本书各章的内容来说明。

双剪强度理论,国外一华裔学者曾称之为“血汗理论”,或许他用来说明研究工作之艰辛,得来之不易。但今天回顾这些工作又是那么自然而简单。回首往事,作者向一切关心、支持、帮助、参加研究以及进行各种讨论的众多师长、各有关专家、国内外同行以及有关研究生表示衷心的感谢。作者也对西安交通大学何丽南副教授协助本书的著述,西安交通大学学术专著出版基金委员会的支持,以及西安交通大学出版社总编杨蔚百教授对本书写作的促进和国家自然科学基金委员会对本书内容有关课题研究的支持,表示衷心的感谢。由于双剪强度理论为一新的理论,书中内容不当之处恐所难免,热切盼望各位读者予以指正。

30 年成书,效率不高。全书交稿之后,应航空航天工业部和空军航空工程部之邀,来珠海开会,会余之暇完成此文。今天与北京航空航天大学 and 航空航天工业部两位教授同登珠海拱北芳园大厦旋转餐厅小憩。遥望四周,海天山色,深感大地之雄伟,个人之渺小。

俞茂铨

1990 年 3 月于珠海