

<<连续损伤力学及其数值分析应用>>

图书基本信息

书名：<<连续损伤力学及其数值分析应用>>

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## 前言

The progress of failure in metals, under various loading conditions, is assumed to involve the degradation of a structure due to nucleation and growth of defects, such as microvoids and microcracks, and their coalescence into macrocracks. This process, generically termed damage, was first used to predict material failure and rupture in-service in an elevated condition. Although damage mechanics provides a measure of material degradation on a micromechanics scale, the damage variables are introduced to reflect average material degradation on a macromechanics scale and thus continuum damage mechanics (CDM) was developed. In the micro-cracking of materials under different stress conditions, damage is regarded as the progressive degradation. This material degradation is reflected in the non-linear behaviour of the structures. Non-linear analysis based on CDM provides conservative and realistic results. Since the pioneering work of Kachanov in 1958, continuum damage mechanics has been widely accepted to describe progressive failure due to material degradation. The reason for its popularity is as much the intrinsic simplicity and versatility of the approach, as well as its consistency based on the theory of the thermodynamics of irreversible processes. When the crack profiles are not known a priori, the continuum damage mechanics approaches are computationally very attractive. CDM is a very applicable and rapidly developing discipline. Now many papers are published and several international conferences, e.g., IUTAM-Symposia or EUROMECH-Colloquia, take place. Furthermore, a special International Journal of Damage Mechanics stresses the importance of this branch of solid mechanics.

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### 内容概要

The theoretical framework of continuum damage mechanics presented in this book is based on the thermodynamic theory of energy and material dissipation, and is described by employing a group of internal state variables as a set of fundamental formulations of constitutive equations of damaged materials, development equations of the damaged state, and evolution equations of micro-structures. According to concepts of damage-dissipation of the material state and effective evolution of material properties, all these advanced equations, which take damage aspects into account, are developed and modified from the traditional general failure models, because they are more easily applied and verified in a very wide range of engineering practices by experimental tests, either macroscopically or microscopically. The most practical applications of the theory developed in this book are presented in different engineering topics analyzed by a specified numerical method. Some essential programs of the continuum damage mechanics are listed in the appendices.

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作者简介

Dr. Wohua Zhang is a Professor at Engineering Mechanics Research Center in Zhejiang University of China. Dr. Yuanqiang Cai is a Professor at Department of Civil Engineering in Zhejiang University of China.

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## 章节摘录

插图：Costin and Stone [2-196], using the elastic stress intensity factor for penny-shaped micro-cracks, presented a constitutive equation based on energy function in a manner similar to that of Krajcinovic and Fonseka [2-39]. A proper form of the stiffness matrix for anisotropic damaged materials was proposed by Chaboche [2-38], in which the fourth order tensor reflects the fluctuations of the displacement field within the unit cell. Horii and Nemat-Nasser [2-223] deduced similar forms of the stress-strain relations. In order to develop the constitutive relationship for anisotropic damage it may be necessary to introduce either a fourth order stiffness tensor [2-38, 2-66] or dyadic product of four axial stiffness vectors [2-224] for the symmetrization. A unified constitutive relation for brittle damage and fatigue damage models was presented in [2-39, 2-46, 2-183]. In the case of brittle damage, a damage-surface in the strain space was introduced into the brittle law. In the case of fatigue damage, this damage-surface was substituted into the fatigue law based on the concepts of Lubliner's loading-unloading irreversibility [2-183, 2-215, 2-42, 2-44]. However, a bounding surface and possibly an endurance domain was also contained in this model. The expressions presented in [2-44] imply that the flux of damage is dependent on the energy dissipation only. Therefore, the normality principle is not valid, for example when friction becomes an important mode of energy dissipation. Dragon [2-227, 2-110] applied continuum damage mechanics to quasi-brittle materials to study the plastic-brittle damage behavior of rock and concrete materials based on a continuum model. Halm, [2-228] and Ilankamban and Krajcinovic [2-224] presented a modular damage model for quasi-brittle solids to study the interaction between initial and damage induced anisotropy. In Article [2-229], Govindjee et al. developed an anisotropic quasi-brittle damage model for numerical simulation of brittle damage in concrete structures. Lu et al. [2-225] have studied damage waves in elastic-brittle materials and solved a one dimension wave propagation problem theoretically. Alternatively, Zhang and Mai [2-226] studied the concept of a damage wave and provided a simplified theory of damage waves propagation in elastic-brittle materials.

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编辑推荐

This book presents a systematic development of the theory of Continuum Damage Mechanics and its numerical engineering applications with a unified form of mathematical formulations in anisotropic and isotropic damage models. The areas studied in this book are ( 1 ) Review of damage mechanics ; ( 2 ) Basis of isotropic damage mechanics ; ( 3 ) Brittle damage mechanics of rock mass ; ( 4 ) Theory of isotropic elasto-plastic damage mechanics ; ( 5 ) Basis of anisotropic damage mechanics ; ( 6 ) Theory of anisotropic elasto-plastic damage mechanics ; ( 7 ) Theory of elasto-visco-plastic damage mechanics ; ( 8 ) Dynamics of damage problems ; ( 9 ) Fatigue damage of dynamic structures ; ( 10 ) Micro-damage mechanics ; ( 11 ) Random damage mechanics ; ( 12 ) Numerical method in continuum damage mechanics ; ( 13 ) Application of damage mechanics to problems coupled with multiphase medium.

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