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Stability Loss and Buckling Delamination

Non-smooth Mechanics and Applications

Fracture Mechanics

American Society for Composites, Eighth Proceedings
Current Trends and Open Problems in Computational Mechanics

This book presents an analysis of eight non-classical problems of fracture and failure mechanics mainly obtained by research in the department of dynamics and stability of continuum of the S. P. Timoshenko Institute of Mechanics of the National Academy of Sciences of Ukraine (NAS of Ukraine). It focuses on the application of the 3D (three-dimensional) theories of stability, dynamics, and statics of solid mechanics to the investigation of non-classical problems of fracture and failure mechanics.

Applied Fracture Mechanics

Fundamentals of Fracture Mechanics

The purpose of this symposium is to bring together scientists working on continuum theories of discrete mechanical and thermodynamical systems in the realm of mathematics, theoretical and applied mechanics, physics, material science and engineering. It aims to join together the divergent languages, questions and methods developed in the respective disciplines and to stimulate broad interdisciplinary exchange of ideas and results. The main topics, discussed in the lectures, concern thermodynamics, transport theory, statistical mechanics; continuum mechanics of complex fluids and deformable solids with microstructure; continuum theory of living structures; defect dynamics, synergetics, solitons, coherent structures; dislocations and plasticity; fundamentals of fracture mechanics.

Proceedings of the Second International Conference on Theoretical, Applied and Experimental Mechanics

This book investigates stability loss problems of the viscoelastic composite materials and structural members within the framework of the Three-Dimensional Linearized Theory of Stability (TDLTS). The stability loss problems are considered the development of the initial infinitesimal imperfection in the structure of the material or of the structural members. This development is studied within the framework of the Three-Dimensional Geometrical Non-Linear Theory of the Deformable Solid Body Mechanics. The solution to the corresponding boundary-value problems is presented in the series form in the small parameter which characterizes the degree of the initial imperfection. In this way, the nonlinear problems for the domains bounded by noncanonical surfaces are reduced for the same nonlinear problem for the corresponding domains bounded by canonical surfaces and the series subsequent linearized problems. It is proven that the equations and relations of these linearized problems coincide with the corresponding ones of the well-known TDLTS. Under concrete investigations as stability loss criterion the case is taken for the initial infinitesimal imperfection that starts to increase indefinitely. Moreover, it is proven that the critical parameters can be determined by the use of only the zeroth and first approximations.

Fracture Failure Analysis of Fiber Reinforced Polymer Matrix Composites

Finite Elements in Fracture Mechanics

Applied Mechanics Reviews

Solution of Crack Problems

Most design engineers are tasked to design against failure, and one of the biggest causes of product failure is failure of the material due to fatigue/fracture. From leading experts in fracture mechanics, this new text provides new approaches and new applications to advance the understanding of crack initiation and propagation. With applications in composite materials, layered structures, and microelectronic packaging, among others, this timely coverage is an important resource for anyone studying or applying concepts of fracture mechanics. Concise and easily understood mathematical treatment of crack tip fields (chapter 3) provides the basis for applying fracture mechanics in solving practical problems. Unique coverage of bi-material interfacial cracks (chapter 8), with applications to commercially important areas of composite materials, layered structures, and microelectronic packaging. A full chapter (chapter 9) on the cohesive zone model approach, which has been extensively used in recent years to simulate crack propagation. A unified discussion of fracture criteria involving nonlinear/plastic deformations

Continuum Models And Discrete Systems - Proceedings Of The Eighth International Symposium

The second edition of this textbook includes a refined presentation of concepts in each chapter, additional examples; new problems and sections, such as conformal mapping and mechanical behavior of wood; while retaining all the features of the original book. The material included in this book is based upon the development of analytical and numerical procedures pertinent to particular fields of linear elastic fracture mechanics (LEFM) and plastic fracture mechanics (PFM), including mixed-mode-loading interaction. The mathematical approach undertaken herein is coupled with a brief review of several fracture theories available in cited references, along with many color images and figures. Dynamic fracture mechanics is included through the field of fatigue and Charpy impact testing.

IUTAM Symposium on Discretization Methods for Evolving Discontinuities
This volume constitutes the Proceedings of the IUTAM Symposium on "Analytical and Computational Fracture Mechanics of Non-homogeneous Materials", held in Cardiff from 18th to 22nd June 2001. The Symposium was convened to address and place on record topical issues in analytical and computational aspects of the fracture of non-homogeneous materials as they are approached by specialists in mechanics, materials science and related fields. The expertise represented in the Symposium was accordingly very wide, and many of the world’s greatest authorities in their respective fields participated. Given the extensive range and scale of non-homogeneous materials, it had to be focussed to enhance the quality and impact of the Symposium. The range of non-homogeneous materials was limited to those that are inhomogeneous at the macroscopic level and/or exhibit strain softening. The issues of micro to macro scaling were not excluded even within this restricted range which covered materials such as rock, concrete, ceramics and composites on the one hand, and, on the other, those metallic materials whose ductile fracture is strongly influenced by the presence of inhomogeneities. The Symposium remained focussed on fundamental research issues of practical significance. These issues have many common features among seemingly disparate non-homogeneous materials.

Fracture Mechanics

Probabilistic fracture mechanics and reliability

These volumes, 7 and 8, of Fracture Mechanics of Ceramics constitute the proceedings of an international symposium on the fracture mechanics of ceramic materials held at Virginia Polytechnic Institute and State University, Blacksburg, Virginia on June 19, 20 and 21, 1985. These proceedings constitute the fourth pair of volumes of a continuing series of conferences. The theme of this conference, as the previous three, focused on the mechanical behavior of ceramic materials in terms of the characteristics of cracks, particularly the roles which they assume in the fracture process. The 78 contributed papers by over 100 authors and co-authors represent the current state of the field. They address many of the theoretical and practical problems of interest to those concerned with brittle fracture. The program chairmen gratefully acknowledge the financial assistance for the Symposium provided by the Exxon Foundation, the Army Research Office, the National Science Foundation, and the Office of Naval Research. Without their support, this conference simply would not have been possible. The suggestions of Drs. J. C. Hurt, R. C. Pohanka, and L. Toth were particularly helpful in assuring the success of this symposium. Special appreciation is extended to Professor J. I. Robertson, C. P. Mikes Professor of History, whose presentation following the banquet on the American Civil War was very well received by the audience. Finally, we wish to thank our joint secretaries, especially Karen Snider, for their patience and help in finally bringing these proceedings to press.

Methods of Analysis and Solutions of Crack Problems

Fracture and mechanics is concerned with the experimental method of static and dynamic caustics and the Distribution of Determinant (Det.)-criterion of fracture. The Det.-criterion determines the conditions causing a crack and gives information on the expected angle of crack propagation. The object of this publication is to present the latest results to the research and development community and to assist the teaching of experimental fracture mechanics and stress analysis in undergraduate and postgraduate courses. After discussing the basic theoretical considerations on the subject, experimental techniques and applications are introduced. Most of the results presented are based on the author’s own investigations in the field of experimental mechanics since 1973 at the National Technical University of Athens.

Mechanics of Fatigue

In this book a new phenomological approach to brittle medium fracture initiation under shock pulses is developed. It provides an opportunity to estimate fracture of media with and without macrodefects. A qualitative explanation is thus obtained for a number of principally important effects of high-speed dynamic fracture that cannot be clarified within the framework of previous approaches. It is possible to apply this new strategy to resolve applied problems of disintegration, erosion, and dynamic strength determination of structural materials. Specialists can use the methods described to determine critical characteristics of dynamic strength and optimal effective fracture conditions for rigid bodies. This book can also be used as a special educational course on deformation of materials and constructions, and fracture mechanics.

Damage Tolerance in Aircraft Structures

A team of scholars united for this project in order to provide an almanac of some of the more recent achievements in fracture science and to compile a topical reference book with first-hand information on the methods and ideas in this field. Every section was written by the originator of, or one of the top experts in the corresponding area, with emphasis on the most dynamic portion of this fast-growing and challenging science. This volume is suitable as a supplementary book for advanced courses on fracture and materials science.

Energy Research Abstracts

In recent years, discretization methods have been proposed which are more flexible and which have the potential of capturing (moving) discontinuities in a robust and efficient manner. This monograph assembles contributions of leading experts with the most recent developments in this rapidly evolving field. It provides the most comprehensive coverage of state-of-the-art numerical methods for treating discontinuities in mechanics.

Proceedings of 8th GACM Colloquium on Computational Mechanics

This book addresses the problems of fracture mechanics of materials with cracks under the loading directed along the cracks.
It considers two non-classical fracture mechanisms, namely the fracture of bodies compressed along cracks and the fracture of materials with initial (residual) stresses acting in parallel to the surfaces of cracks location, and presents new approaches (also including combined one) developed in the framework of three-dimensional linearized mechanics of deformable bodies. It then discusses the results of studies on two- and three-dimensional problems for various configurations of crack locations in isotropic and anisotropic materials, and based on these results, critically evaluates the accuracy and applicability limits of the “beam approximation” approach, which is widely used to study various problems of the fracture of bodies under compression along parallel cracks.

### IUTAM Symposium on Analytical and Computational Fracture Mechanics of Non-Homogeneous Materials

This conference book contains papers presented at the 8th GACM Colloquium on Computational Mechanics for Young Scientists from Academia and Industry. The conference was held from August 28th – 30th, 2019 in Kassel, hosted by the Institute of Mechanics and Dynamics of the department for civil and environmental engineering and by the chair of Engineering Mechanics / Continuum Mechanics of the department for mechanical engineering of the University of Kassel. The aim of the conference is, to bring together young scientists who are engaged in academic and industrial research on Computational Mechanics and Computer Methods in Applied Sciences. It provides a platform to present and discuss recent results from research efforts and industrial applications. In more than 150 presentations, given by young scientists, current scientific developments and advances in engineering practice in this field are presented and discussed. The contributions of the young researchers are supplemented by a plenary session and plenary talks from four senior scientists from academia and industry as well as from the GACM Best PhD Award winners 2017 and 2018.

### Micromechanics of Fracture in Generalized Spaces

Fracture mechanics has established itself as an important discipline of growing interest to those working to assess the safety, reliability and service life of engineering structures and materials. In order to calculate the loading situation at cracks and defects, nowadays numerical techniques like finite element method (FEM) have become indispensable tools for a broad range of applications. The present monograph provides an introduction to the essential concepts of fracture mechanics, its main goal being to procure the special techniques for FEM analysis of crack problems, which have to date only been mastered by experts. All kinds of static, dynamic and fatigue fracture problems are treated in two- and three-dimensional elastic and plastic structural components. The usage of the various solution techniques is demonstrated by means of sample problems selected from practical engineering case studies. The primary target group includes graduate students, researchers in academia and engineers in practice.

### Fracture Mechanics

This book is concerned with the numerical solution of crack problems. The techniques to be developed are particularly appropriate when cracks are relatively short, and are growing in the neighbourhood of some stress raising feature, causing a relatively steep stress gradient. It is therefore practicable to represent the geometry in an idealised way, so that a precise solution may be obtained. This contrasts with, say, the finite element method in which the geometry is modelled exactly, but the subsequent solution is approximate, and computationally more taxing. The family of techniques presented in this book, based loosely on the pioneering work of Eshelby in the late 1950’s, and developed by Erdogan, Keer, Mura and many others cited in the text, present an attractive alternative. The basic idea is to use the superposition of the stress field present in the unfaulted body, together with an unknown distribution of ‘strain nuclei’ (in this book, the strain nucleus is the dislocation), chosen so that the crack faces become traction-free. The solution used for the stress field for the nucleus is chosen so that other boundary conditions are satisfied. The technique is therefore efficient, and may be used to model the evolution of a developing crack in two or three dimensions. Solution techniques are described in some detail, and the book should be readily accessible to most engineers, whilst preserving the rigour demanded by the researcher who wishes to develop the method itself.

### Fracture Mechanics

### Recent Advances in Mechanics

### Mechanics of Generalized Continua

The book “Applied Fracture Mechanics” presents a collection of articles on application of fracture mechanics methods to materials science, medicine, and engineering. In thirteen chapters, a wide range of topics is discussed, including strength of biological tissues, safety of nuclear reactor components, fatigue effects in pipelines, environmental effects on fracture among others. In addition, the book presents mathematical and computational methods underlying the fracture mechanics applications, and also developments in statistical modeling of fatigue. The work presented in this book will be useful, effective, and beneficial to mechanical engineers, civil engineers, and material scientists from industry, research, and education.

### Dynamics of Fracture

In their 1909 publication Théorie des corps déformables, Eugène and François Cosserat made a historic contribution to materials science by establishing the fundamental principles of the mechanics of generalized continua. The chapters collected in this volume showcase the many areas of continuum mechanics that grew out of the foundational work of the Cosserat brothers. The included contributions provide a detailed survey of the most recent theoretical developments in the
field of generalized continuum mechanics and can serve as a useful reference for graduate students and researchers in mechanical engineering, materials science, applied physics and applied mathematics.

Fracture of Materials Under Compression Along Cracks

By the detailed analysis of the modern development of the mechanics of deformable media can be found the deep internal contradiction. From the one hand it is declared that the deformation and fracture are the hierarchical processes which are limited and unite several structural and scale levels. From the other hand the sequential investigation of the hierarchy of the deformation and destruction is not carried out. The book’s aim is filling this mentioned gap and investigates the hot topic of the fracture of non-ideal media. From the microscopic point of view in the book we study the hierarchy of the processes in fractured solid in the whole diapason of practically used scales. According the multilevel hierarchical system ideology under "microscopic" we understand taking into account the processes on the level lower than relative present strata. From hierarchical point of view the conception of "microscopic fracture can be soundly applied to the traditionally macroscopic area, namely geomechanics or main crack propagation. At the same time microscopic fracture of the nanomaterials can be well-grounded too. This ground demands the investigation on the level of inter-atomic interaction and quantum mechanical description. The important feature of the book is the application of filtered manifolds and non-Euclidean spaces to the description of the processes of deformation and fracture in inhomogeneous and defected continua. The non-Euclidean spaces for the dislocations' description were introduced by J. F. Nye, B.A. Bilby, E. Kerner, K. Kondo in fifteenth. In last decades this necessity was shown in geomechanics and theory of seismic signal propagation. The applications of non-Euclidean spaces to the plasticity allow us to construct the mathematically satisfying description of the processes. Taking into account this space expansion the media with microstructure are understood as Finsler space media. The bundle space technique is used for the description of the influence of microstructure on the continuum metrics. The crack propagation is studied as a process of movement in Finsler space. Reduction of the general description to the variational principle in engineering case is investigated and a new result for the crack trajectory in inhomogeneous media is obtained. Stability and stochasticization of crack trajectory in layered composites is investigated. The gauge field is introduced on the basis of the structure representation of Lie group generated by defects without any additional assumption. Effective elastic and non-elastic media for nanomaterials and their geometrical description are discussed. The monograph provides the basis for more detailed and exact description of real processes in the material. The monograph will be interesting for the researchers in the field of fracture mechanics, solid state physics and geomechanics. It can be used as well by the last year students wishing to become more familiar with some modern approaches to the physics of fracture and continual theory of dislocations. In Supplement, written by V.V. Barakline, quantum mechanical concept of physical body wholeness according to H. Primas is discussed with relation to fracture. Role of electronic subsystem in fracture dynamics in adiabatic and non-adiabatic approximations is clarified. Potential energy surface of ion subsystem accounting electron contribution is interpreted as master parameter of fracture dynamics. Its features and relation to non-Euclidean metrics of defected solid body is discussed. Quantum mechanical criteria of fracture arising are proposed.

Mathematical Methods in Scattering Theory and Biomedical Engineering

Composite materials are heterogeneous by nature, and are intended to be, since only the combination of different constituent materials can give them the desired combination of low weight, stiffness and strength. At present, the knowledge has advanced to a level that materials can be tailored to exhibit certain, required properties. At the same time, the fact that these materials are composed of various, sometimes very different constituents, makes their mechanical behaviour complex. This observation holds with respect to the deformation behaviour, but especially with respect to the failure behaviour, where complicated and unconventional failure modes have been observed. It is a challenge to develop predictive methods that can capture this complex mechanical behaviour, either using analytical tools, or using numerical means, the finite element method being the most widespread among the latter. In this respect, developments have gone fast over the past decade. Indeed, we have seen a paradigm shift in computational approaches to (composite) material behaviour. Where only a decade ago it was still customary to carry out analyses of deformation and failure at a macroscopic level of observation only - one may call this a phenomenological approach - nowadays this approach is being progressively replaced by multiscale methods. In such methods it is recognized a priori that the overall behaviour is highly dependent on local details and flaws.

Fracture Mechanics of Ceramics

Theoretical treatments of fracture mechanics abound in the literature. Among the first books to address this vital topic from an applied standpoint was the first edition of Practical Fracture Mechanics in Design. Completely updated and expanded to reflect recent developments in the field, the second edition of this valuable reference concisely reviews all of the fracture modes and design methodologies needed for control and prevention of structural failures in mechanical components. Practical Fracture Mechanics in Design, Second Edition begins with the historical development of the field, which is critical in understanding the origins and purpose of the various methodologies and equations. The book goes on to provide the fundamentals, basic formulas, elementary worked examples, and references with an emphasis on linear elastic fracture mechanics (LEFM). The author also includes case studies and design problems to clarify the concepts and explain their application. New chapters cover experimental methods in fracture, fracture of composite materials, dynamic fracture, and post-mortem analysis of fracture surfaces. Providing much more than a simple introduction to fracture mechanics, this critical, authoritative guide supplies easy-to-use and understand tools based on hands-on experience in design, emphasizing practical applications over heavily theoretical, rigorous mathematical derivations.

Mechanics of Material Forces

This book presents, in a unified manner, a variety of topics in Continuum and Fracture Mechanics: energy methods, conservation laws, mathematical methods to solve two-dimensional and three-dimensional crack problems. Moreover, a series of new subjects is presented in a straightforward manner, accessible to undergraduate students. Emphasizing physical or experimental back-grounds, then analysis and theoretical results, this monograph is intended for use by students and
Researchers in solid mechanics, mechanical engineering and applied mathematics.

Fracture Mechanics

This book presents a unified approach to fracture behavior of natural and synthetic fiber-reinforced polymer composites on the basis of fiber orientation, the addition of fillers, characterization, properties and applications. In addition, the book contains an extensive survey of recent improvements in the research and development of fracture analysis of FRP composites that are used to make higher fracture toughness composites in various applications. The FRP composites are an emerging area in polymer science with many structural applications. The rise in materials failure by fracture has forced scientists and researchers to develop new higher strength materials for obtaining higher fracture toughness. Therefore, further knowledge and insight into the different modes of fracture behavior of FRP composites are critical to expanding the range of their application.

Practical Fracture Mechanics in Design

This book is the first of 2 special volumes dedicated to the memory of Gérard Maugin. Including 40 papers that reflect his vast field of scientific activity, the contributions discuss non-standard methods (generalized model) to demonstrate the wide range of subjects that were covered by this exceptional scientific leader. The topics range from micromechanical basics to engineering applications, focusing on new models and applications of well-known models to new problems. They include micro-macro aspects, computational endeavors, options for identifying constitutive equations, and old problems with incorrect or non-satisfying solutions based on the classical continua assumptions.

Fracture Mechanics

This volume comprises the papers presented at the Seventh International Workshop on Scattering Theory and Biomedical Engineering, focusing on the hottest topics in scattering theory and biomedical technology. All the contributions are state-of-the-art and have been fully reviewed. The authors are recognized as being eminent both in their field and in the science community. Sample Chapter(s). Chapter 1: A Method to Solve Inverse Scattering Problems for Electromagnetic Fields in Chiral Media (891 K B): Contents: A Method to Solve Inverse Scattering Problems for Electromagnetic Fields in Chiral Media (C Athanasiadis & E Kardasi); Nonlinear Integral Equations in Inverse Obstacle Scattering (O Ivanovych & R Kress); Homogenization in Chiral Elasticity (G Barbaris & I G Stratis); Shape Control and Damage Identification of Piezoelectric Smart Beams Using Finite Element Modelling and Genetic Optimization (E P Hadjiigeorgiou et al.); A Fast Numerical Method for a Simplified Phase Field Model (C A Sfyrikas & V A Dougalis); On the Hidden Electromagnetic Activity of the Brain (G Dassios); A Decision Tree Based Approach for the Identification of Ischaemic Beats in ECG Recordings (T P Exarchos et al.); An Automatic Microcalcification Detection System Utilizing Mammographic Enhancement Techniques (A N Papadopoulos & D I Fotiadis); A Multidimensional Cardiac Model (D G Tsalikakis et al.); Mobile and Electronic Medical Support and Education for Dyslexic Students (M Virovč & E A lepis); and other papers. Readership: Graduate students, academics and researchers in industry working in biomedical engineering, computational biology, mathematical biology and mathematical physics.

Mechanics of Fracture Initiation and Propagation

The notion dealt with in this volume of proceedings is often traced back to the late 19th-century writings of a rather obscure scientist, C. V. Burton. A probable reason for this is that the painstaking deciphering of this author's paper in the Philosophical Magazine (Vol. 33, pp. 191-204, 1891) seems to reveal a notion that was introduced in mathematical form much later, that of local structural rearrangement. This notion obviously takes place on the material manifold of modern continuum mechanics. It is more or less clear that seemingly different phenomena - phase transition, local destruction of matter in the form of the loss of local ordering (such as in the appearance of structural defects or of the loss of cohesion by the appearance of damage or the extension of cracks), plasticity, material growth in the bulk or at the surface by accretion, wear, and the production of debris - should enter a common framework where, by pure logic, the material manifold has to play a prominent role. Finding the mathematical formulation for this was one of the great achievements of J. D. Eshelby. He was led to consider the apparent but true motion or displacement of embedded material inhomogeneities, and thus he began to investigate the "driving force" causing this motion or displacement, something any good mechanician would naturally introduce through the duality inherent in mechanics since J. L. d'Alembert.

Eight Non-Classical Problems of Fracture Mechanics

This is the proceedings of the 2nd International Conference on Theoretical, Applied and Experimental Mechanics that was held in Corfu, Greece, June 23-26, 2019. It presents papers focusing on all aspects of theoretical, applied and experimental mechanics, including biomechanics, composite materials, computational mechanics, constitutive modeling of materials, dynamics, elasticity, experimental mechanics, fracture, mechanical properties of materials, micromechanics, nanomechanics, plasticity, stress analysis, structures, wave propagation. The papers update the latest research in their field, carried out since the last conference in 2018. This book is suitable for engineers, students and researchers who want to obtain an up-to-date view of the recent advances in the area of mechanics.

Fracture Mechanics

The assessment of crack initiation and/or propagation has been the subject of many past discussions on fracture mechanics. Depending on how the chosen failure criterion is combined with the solution of a particular theory of continuum mechanics, the outcome could vary over a wide range. Modelling of the material damage process could be elusive if the scale level of observation is left undefined. The specification of physical dimension alone is not sufficient because time and temperature also play an intimate role. It is only when the latter two variables are fixed that failure predictions can be simplified.
The sudden fracture of material with a pre-existing crack is a case in point. Barring changes in the local temperature,* the energy released to create a unit surface area of an existing crack can be obtained by considering the change in elastic energy of the system before and after crack extension. Such a quantity has been referred to as the critical energy release rate, $G_e$, or stress intensity factor, $K_{II}$. Other parameters, such as the crack opening displacement (COD), path-independent $J$-integral, etc., have been proposed; their relation to the fracture process is also based on the energy release concept. These one-parameter approaches, however, are unable simultaneously to account for the failure process of crack initiation, propagation and onset of rapid fracture. A review on the use of $G$, $K_{I}$, COD, $J$, etc., has been made by Sih [1,2].

**Generalized Models and Non-classical Approaches in Complex Materials**

It is well known that the traditional failure criteria cannot adequately explain failures which occur at a nominal stress level considerably lower than the ultimate strength of the material. The current procedure for predicting the safe loads or safe useful life of a structural member has been evolved around the discipline of linear fracture mechanics. This approach introduces the concept of a crack extension force which can be used to rank materials in some order of fracture resistance. The idea is to determine the largest crack that a material will tolerate without failure. Laboratory methods for characterizing the fracture toughness of many engineering materials are now available. While these test data are useful for providing some rough guidance in the choice of materials, it is not clear how they could be used in the design of a structure. The understanding of the relationship between laboratory tests and fracture design of structures is, to say the least, deficient. Fracture mechanics is presently at a standstill until the basic problems of scaling from laboratory models to full size structures and mixed mode crack propagation are resolved. The answers to these questions require some basic understanding of the theory and will not be found by testing more specimens. The current theory of fracture is inadequate for many reasons. First of all it can only treat idealized problems where the applied load must be directed normal to the crack plane.

**Lecture Notes on Composite Materials**

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