Preface

This volume of the *Advanced Structured Materials* Series is dedicated to Prof. Holm Altenbach, the leading researcher and teacher in the field of applied mechanics from the Faculty of Mechanical Engineering, Institute of Mechanics, Otto-von-Guericke-University Magdeburg (Germany) on the occasion of his 60th birthday.

Holm has made contributions in many fields of applied mechanics, including theory of shells, mechanics of composite materials, yield and failure criteria, constitutive models for inelastic behavior, continuum damage mechanics, micro-polar continua as well as mechanics of nano-sized structures. His achievements in these areas have led to numerous national and international awards.

Holm holds honorary doctorates from the National Technical University, "Kharkiv Polytechnical Institute", Kharkiv (Ukraine), the Ovidius University, Constanta (Romania) and I. Javakhishvili Tbilisi State University (Georgia). Amongst numerous awards he received, two notable medals are Gold-Medal of the Mechanical Engineering Faculty, Politechnika Lubelska and Semko-Medal, National Technical University, "Kharkiv Polytechnical Institute".

He is Editor-in-Chief of *Zeitschrift für Angewandte Mathematik und Mechanik* (ZAMM, Journal of Applied Mathematics and Mechanics) and member of the editorial boards of *The Journal of Strain Analysis for Engineering Design*, *Mechanics of Composite Materials*, *Continuum Mechanics and Thermodynamics* and *Technische Mechanik*.

Among many international conferences and advanced courses Holm organized or co-organized, some are as follows: the CISM-Courses in Udine, Italy *Creep and Damage in Materials and Structures (1998)*, *Modern Trends in Composite Laminates Mechanics (2002)*, *Cellular and Porous Materials: Modeling - Testing - Application (2009)*, *Generalized Continua - From the Theory to Engineering Applications (2011)*, *Failure and Damage Analysis of Advanced Materials (2013)*, *Shell-like Structures - Advanced Theories and Applications (2014)*, EUROMECH Colloquia *444 Critical Review of the Theories of Plates and Shells and New Applications (2002)*, *527 Shell-like Structures - Nonclassical Theories and Applications (2011)* as well as international seminars on different aspects of *Mechanics of Generalized Continua* (2010) and (2012) in Lutherstadt Wittenberg and (2015) in Magdeburg.

Holm Altenbach was born in 1956 in Leipzig and grew up in Magdeburg, where he attended the Polytechnic Advanced High School. He passed the high school graduation exam, "Reifeprüfung", at the Martin-Luther-University Halle-Wittenberg in 1974. He went to Leningrad Polytechnical Institute (today St. Petersburg State Polytechnical University) to study Energy Engineering (1974–1975) and Dynamic and Strength of Machines (1975–1980), where he graduated with distinction.

During his graduation, Holm started his research in applied mechanics. His first experience was to find effective properties of a composite plate from the given properties of constituents. Holm continued to explore composite plates and shells during his Ph.D. study (1980–1983) under the supervision of Profs. P.A. Zhilin and V.A. Palmov from the Chair "Mechanics and Control Processes" at St. Petersburg State Polytechnical University. At that time, this was a prestigious school in the field of solid mechanics, founded by A.I. Lurie, the famous Russian and Soviet scientist. First paper by Holm in co-authorship with Zhilin was on the stability of shells (Altenbach and Shilin 1982) and then with Palmov was on the topic Cosserat-type plate theory (Palmow and Altenbach 1982) appeared in the local journal, Journal of TH "Otto von Guericke" Magdeburg.[1] In this university, Holm held research fellowship as assistant (1980–1987) and senior assistant (1987–1995). Holm returned to St. Petersburg in 1987 to defend his second doctoral thesis and received the degree "Doctor of Technical Sciences".[2] The objective of the thesis was to develop a nonlinear theory of shells under consideration of visco-elastic material properties. Holm presented the main results in Ingenieur-Archiv

[1]TH "Otto von Guericke" Magdeburg was founded on August 6, 1953 as Hochschule (higher educational institute) of heavy machinery, in 1961 it was renamed as TH (technical higher educational institute) Magdeburg, in 1987 in Technical University Otto von Guericke. In 1993 the Otto-von-Guericke-University Magdeburg was founded upon the former TH.

[2]This degree is equivalent the habilitation in Germany.

(Altenbach 1988)—it was his first publication in the western part of Germany.[3] One feature of his approach is that the theory is developed from the basic principles of rational mechanics, directly for the thin shells. This is in contrast to the diverse shell theories which are derived from equations of three-dimensional continuum mechanics by mathematical or numerical techniques, for example, asymptotic methods or variational principles. The direct approach is robust and elegant as the balance laws are applied for shells. On the other hand, it is rather complex, since constitutive equations must be formulated for stress resultants (Altenbach and Zhilin 1988). This requires to extend the classical concepts of material and physical symmetries and to develop new approaches as how to identify the material properties of shells. At that time it was not quite clear, why such an expensive direct approach might have been advantageous. In the last two decades, engineers have been dealing with materials which cannot be modeled by the three-dimensional Cauchy continuum and interestingly some materials even do not exist in a "three-dimensional form". Examples include coatings, (organic) light-emitting diodes, silicon photovoltaic cells, and thin films.

MARTIN-LUTHER-UNIVERSITÄT
HALLE-WITTENBERG
Fachbereich Werkstoffwissenschaften
Institut für Werkstoffwissenschaft
Prof. Dr.-Ing. habil. Holm Altenbach
Geschäftsführender Direktor des Institutes

In 1996, Holm was appointed Full Professor of Engineering Mechanics at the Martin-Luther-University Halle-Wittenberg. His chair was integrated with the Department of Materials Sciences and the Institute of Materials Science.[4] Holm specialized in the research of mechanics of thin-walled structures. One aspect was to consider inelastic material behavior including creep and damage (Altenbach et al. 1997; Altenbach 2002). Another point was the modeling of laminates and shells made from short-fiber-reinforced materials. For such modeling, the manufacturing process should be analyzed first to predict the orientation of short fibers during the flow of fiber suspensions. Here the micro-polar (Cosserat-type) continuum theory is required to capture independent rotations of short fibers (Altenbach et al. 2003b, 2007). Knowing the orientation states of fibers, one should estimate anisotropic material properties to investigate deformations and stress state in thin-walled components (Altenbach et al. 2003a; Kröner et al. 2009).

[3]In those years it was not easy to publish research results outside the Eastern Bloc countries.

[4]This combination: Department of Materials Sciences (Fachbereich Werkstoffwissenschaften) and Institute of Materials Science (Institut für Werkstoffwissenschaft) was the result of several restructuring stages of the former Technische Hochschule für Chemie Leuna-Merseburg. In 1998 the department was renamed as Department of Engineering Sciences. In 2003 the department and the chair were moved to Halle. In 2011, Holm returned with his group to Otto-von-Guericke-University Magdeburg (www.ifme.ovgu.de/ltm).

One of the favorite discussion topics of Holm is the question how to compute the effective transverse shear stiffness of a plate. This is a tricky task even for plates made of linear-elastic materials. Indeed, to find the transverse shear stiffness within the linear theory of elasticity, a nonlinear equation should be solved (Altenbach 2000; Altenbach et al. 2015). As an example, consider a three-layer laminate plate with skin layers made from the same material and a core layer. Let h be the thickness of the plate and h_c be the thickness of the core layer. Assume that the shear moduli are G_c and G_s for the core and skin layers, respectively. Then according to Altenbach (2000), the effective transverse shear stiffness Γ of the plate can be computed as follows

$$\Gamma = \frac{1}{3} G_s h \lambda^2 \left[1 - \alpha^3 (1 - \mu)\right], \quad \mu = \frac{G_c}{G_s}, \quad \alpha = \frac{h_c}{h}, \tag{1}$$

where λ is the least positive root of the following equation

$$\sin \lambda\alpha \, \sin \lambda(1 - \alpha) = \mu \cos \lambda\alpha \, \cos \lambda(1 - \alpha). \tag{2}$$

For homogeneous plates with $\mu = 1$, Eqs. (1) and (2) yield

$$\Gamma = \kappa G h, \quad G = G_s = G_c,$$

where the factor κ takes the value $\pi^2/12$ as originally derived by Mindlin (1951). Sandwich plates applied in lightweight structures are usually composed of relatively thick soft core layer and thin skin layers with a relatively high stiffness. As shown in Altenbach (2000) for sandwich plates, the Reissner's formula (Reissner 1947) follows from Eqs. (1) and (2)

$$\Gamma = G_c h.$$

For laminated glass plates having a thin core layer with the lower shear modulus, the approximate solution of Eq. (2) reads

$$\lambda^2 = \frac{\mu}{\alpha(1 - \alpha)}. \tag{3}$$

With Eq. (1), the approximate value of the transverse shear stiffness is

$$\Gamma = \frac{1}{3} G_c h \frac{1 - \alpha^3 (1 - \mu)}{\alpha(1 - \alpha)}. \tag{4}$$

For thin-walled structures undergoing creep and damage, special iterative procedures are required in order to compute transverse shear deformation (Altenbach and Naumenko 2002).

Beyond the activities on shear correction factors, let us take the opportunity to mention some recent researches by Holm, his students, and collaborators. These

include analysis of shells from functionally graded materials (Altenbach and Eremeyev 2008), photovoltaic modules (Schulze et al. 2012; Weps et al. 2013; Eisentrager et al. 2015a, b), nanoscale shell structures, where surface effects have to be taken into account (Altenbach et al. 2009; Altenbach and Eremeyev 2011; Altenbach et al. 2012), inelastic behavior of advanced heat-resistant materials (Altenbach et al. 2008; Langler et al. 2014), micro-mechanics of grain boundary cavitation under creep conditions (Ozhoga-Maslovskaja et al. 2015) and inelastic micro-polar materials (Altenbach and Eremeyev 2014).

It is not straightforward to identify the exact number of books published and/or edited by Holm. We guess that this number would be in the range between 40 and 50. Let us mention some of his textbooks which are used by many professors for teaching applied mechanics and are popular among students as well. These include Engineering Mechanics (Altenbach 2014), Continuum Mechanics (Altenbach 2015), Theory of Plates (Altenbach et al. 1998), and Mechanics of Composite Structural Elements (Altenbach et al. 2004).

Holm has directly supervised over 30 doctoral students, and countless, doctoral and postdoctoral fellows from different countries. For many years, he has been the board member of the interdisciplinary Graduate School 1554 on *Micro-Macro-Interactions in Structured Media and Particle Systems*[5] funded by the German Research Foundation (Deutsche Forschungsgemeinschaft, abbreviated DFG). Many Ph.D. holders from this school and from the former one[6] have managed academic positions in different universities.

Professor Altenbach with assistants and students. Merseburg, 2002

[5]see homepage: www.grk1554.ovgu.de.

[6]Ph.D. schools ("Graduiertenkollegs", abbreviated GRK) are established by German universities to promote young scientists. Their key emphasis is on the qualification of doctoral researchers within the framework of a focused research program and a structured training strategy. The first Ph.D. school at the TU Magdeburg entitled *Modellierung, Berechnung und Identification mechanischer Systeme* was founded in 1992.

This volume contains a collection of contributions on advanced approaches of continuum mechanics written by leading scientists and collaborators, former Ph.D. students, and friends of Holm around the globe. These articles cover not only modern high-impact research areas but also historical essays and fundamentals. We thank all these distinguished authors for sharing this celebration.

We would like to acknowledge the series editor Prof. Andreas Öchsner for giving us the opportunity to publish this volume. We thank Helal Chowdhury, Johanna Eisenträger, Oliver Junge, and Barbara Renner from the Institute of Mechanics, Otto-von-Guericke-University Magdeburg, for their careful readings of parts of the volume. We would like to acknowledge Dr. Christoph Baumann from Springer Publisher for the assistance and support during the preparation of the book.

We wish Holm a wonderful 60th birthday, continued success, many new scientific papers and books, happiness, as well as excellent health for many years to come.

Magdeburg
March 2016

Konstantin Naumenko
Marcus Aßmus

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