begell house, inc.

Article Title: FOREWORD

Dear Author:

Please review the attached PDF file which contains the author proof of your article.

This is your only opportunity to review the editing, typesetting, figure placement, and correctness of text, tables, and figures. Answer copyeditor's queries in the margin. Failure to answer queries will result in the delay of publication of your article, so please make sure they are all adequately addressed. **You will not be charged for any corrections to editorial or typesetting errors; however, you will be billed at the rate of $25 per hour of production time for rewriting, rewording, or otherwise revising the article from the version accepted for publication ("author's alterations"); any such charges will be invoiced and must be paid before the article is published.**

Please return your corrections clearly marked on the page proofs and upload the corrected file or indicate your corrections in a list, specifying the location of the respective revisions as precisely as possible. If you wish to order offprints (see form below) please fill out and upload the form onto the submission site with your corrections. After uploading all files please be sure to click on the SUBMIT button so that we will be able to access your revisions.

Please read the instructions carefully and **if possible** upload your corrections onto the submission site (http://submission.begellhouse.com/usr/login.html?prod_code=journals) within 48 hours, not including weekends. If you need more time, please let me know at your earliest convenience. No article will be published without confirmation of the author's review. If we do not hear from you within the allotted time, we will be happy to hold your article for a future issue, to give you more time to make your corrections.

Below is a form for ordering offprints, issues, or a subscription. As corresponding author, you will receive a complimentary PDF file of your article upon publication of the journal issue in which your article will appear. If you wish to order extra issues or offprints, please fill in the appropriate areas and submit with your corrections.

Thank you for your assistance, and please reference in all your correspondence.

Sincerely,

Begell House Production

Begell House Production
Contact for Author Proofs

begell house, inc.

Date: September 14, 2012

Journal Name: International Journal for Multiscale Computational Engineering

Volume/Article ID#: Volume 10 / Article # 5558

Article Title: FOREWORD

BILL TO:

SHIP TO:

Dear Author:

As corresponding author, you will receive a complimentary PDF file of your article. Please use the order form below to order additional material and/or indicate your willingness to pay for color printing of figures (if applicable).

Begell House provides our author's institution with a discount for subscriptions to the journal in which their article has been published. For further information please contact Lauren Preville at 1-203-938-1300 or lauren@begellhouse.com.

If placing an order, this form and your method of payment must be returned with your corrected page proofs. Please include cost of shipment as indicated below; checks should be made payable to Begell House, Inc., and mailed to the above address. If a purchase order is required, it may arrive separately to avoid delaying the return of the corrected proofs.

OFFPRINTS OF ARTICLE*					
	PAGE COUNT OF ARTICLE (round off to highest multiple of 8)				
QTY.	4	8	16	24	32
25	72	115	151	187	223
50	84	127	163	199	236
100	108	193	254	314	375
200	156	327	435	544	652
300	205	459	616	773	930

*If your page count or quantity amount is not listed please email a request for prices to journals@begellhouse.com

Black and White Offprints: Prices are quoted above

Offprint Color Pages: Add $3 per color page times the quantity of offprints ordered

Shipping: Add 20% to black and white charge

Offprint Qty: _____ $ _____

Color Pages for Offprints: $ _____

Shipping Charges: $ _____

WIRE TRANSFER

Bank:	**Valley National Bank**
Routing #:	**0 2600 6 790**
Account #:	**07 011343**
Swift Code:	**MBNY US 33**

CREDIT CARD PAYMENT

CREDIT CARD # _____

NAME ON CREDIT CARD _____

AMEX/ VISA/MC/ DISC/ EURO/ _____ EXP. _____

OTHER: _____

CORPORATE PURCHASE ORDER

 P. O. # _____

PAYMENT BY CHECK

INCLUDE THE FOLLOWING INFO ON YOUR CHECK:
Article Reference # and Offprints/Color/Subscription

Make checks payable to Begell House, Inc.

COST FOR COLOR PAGES PRINTED IN JOURNAL	AUTHOR DISCOUNTS

Figures provided in color will appear in color online at no cost.

Price Per Color Page: $ **425.00 per printed page**

Number of Color Pages: _____

Total Cost for Printed Color Pages: $_____

Authors are given a discount when ordering copies of the issue in which their article appears.

Author's Institution is given a discount on an Institutional Subscription to the journal in which the author's article appears.

CONTACT Lauren Preville for details on these discounts, 203-938-1300 or lauren@begellhouse.com

SPECIAL ISSUE

MULTISCALE MECHANICAL MODELLING OF COMPLEX MATERIALS AND ENGINEERING APPLICATIONS 3

Guest Editors

Patrizia Trovalusci & Bernhard Schrefler

FOREWORD

The present volume is a special issue of selected papers from the third edition of a special symposium session on *Multiscale and Multiphysics Computational Methodologies for Complex Materials (M2-CM2)* organized within the framework of the fourth European Conference on Computational Mechanics (ECCM2010), which took place in Paris, France, on May 16–21, 2010. The primary focus of the symposium was to bridge the gap between mechanical engineering and material science providing a forum for the presentation of the fundamental, theoretical, experimental, and practical aspects of mechanical modeling of materials with complex microstructures and complex behavior. This volume follows the issues already edited in the occasion of the first and second editions of two symposium sessions on the same topics (Vancouver, July 2006;nd Berlin, August 2009, within the framework of the International Conference on Processing and Manufacturing of Advanced Materials) (Trovalusci, 2007; Trovalusci and Ostoja-Starzewski, 2011). Each contribution has undergone a standard review process, and only papers that received positive recommendations from at least two international referees, have been included.

The purpose of this special issue is to give an overview of the interdisciplinary research oriented to the mechanical modeling of complex materials. The papers provide a survey of the multiscale approaches proposed to describe materials with complex internal structure. Attention is focused on the description of material complex behaviors dominated by microstructure sizes, such as damage, plasticity, viscosity, etc. Advanced numerical tools and computational strategies developed for the solution of related boundary problems are also presented and addressed to engineering applications. The main guideline connecting papers can be recognized in the formulation of constitutive models for materials with internal length in such a way to account for any kind of nonlocality, implicit (as in the case of continua with additional degrees of freedom) or explicit (through the introduction of integral descriptions). A synthesis of all the contributions are given below.

The paper by Trinh, Janicke, Auffray, Diebels, and Forest deals with present-day issues related to the homogenization methods for micromorphic continua, which widely prove their suitability in describing the constitutive behavior of various kinds of composite materials. In particular, these approaches are effective when the characteristic length associated with the variation of the applied loading conditions becomes of the same order of magnitude of the size of the material inhomogeneities. This work focuses on the choice of polynomial boundary conditions that have to be imposed to the unit cell of microcontinua in order to enhance classical affine conditions for displacements. Differences in the evaluation of standard and nonstandard overall elastic moduli, related to additional fluctuation fields, are studied in the general micromorphic case, as well as in the second gradient and micropolar subcases. The numerical results obtained for two-phase periodic composites as microcontinua of the three cases considered are then compared. The problem of identification of the representative size of the volume element for such microcontinua is also undertaken and a new method to derive size-independent elastic moduli is proposed.

Within the framework of configurational/material thermomechanics, the work by Bargmann and Svendsen proposes an incremental variational formulation for a crystal plasticity model of the strain-gradient type. Generalized plasticity theories are involved in order to predict energetic hardening, taking into account scale-dependent behavior; here described by the variation of plastic strain gradients. This size-dependent plasticity model includes geometrically necessary dislocations as integrant parts of the evolution process. Besides the strain-gradient contribution generally accounted for in the specific literature, the evolution equations for the dislocation density contain contributions from self-hardening and interaction-hardening mechanisms as well as a term arising due to large deformations. The algorithmic formulation of the model is obtained using the explicit discrete variational approach extended to the inelastic nonlocal/phase field context. Some numerical simulations for a two-dimensional polycrystal in simple tension show the capability of the model in predicting length-scale-dependent hardening.

The aim of the paper by Grégoire, Rojas-Solano, and Pijaudier-Cabot is to achieve a consistent description of the continuous–discontinuous transition involved in the failure process of materials, accounting for the variation of the internal length with the state of the damage. In particular, the authors numerically investigate the performances of different integral-type nonlocal formulations that act in competition in terms of internal length evolution as a function of damage. Attention is then focused on the combined effect of the transfer of information through a damaged area, which leads to a decrease in the internal length and of the interactions between growing voids; which conversely leads to an increase of the internal length itself. Results obtained for two one-dimensional problems show that the combination of two specific models provides better results in terms of convergence with respect to mesh refinements, continuum–discontinuum transitions, and mesh-independent damage distributions.

The formulation of constitutive models for microcracked bodies is also addressed in the paper by Bongue Boma, Sudak, and Federico, developed within the framework of generalized continua theory. The macroscopic behavior of these materials has been derived from a micro/macro change of scale, based on the description of the geometry of the crack field. In particular, at the macrolevel a nonlocal (second-gradient type) constitutive law and an additional nonlinear constitutive law for a scalar configurational force are derived from a nonlocal single-crack model described at the underlined microlevel. The micro/macro transition is obtained via volume averaging accounting for the effect of interactions with neighboring cracks. Some numerical tests show the influence of the crack-to-crack interactions on the strength and stiffness of the body.

Again working in the conceptual framework of generalized continua, Stefanou and Sulem perform a homogenization procedure leading to the identification of a third-order micromorphic continuum for the analysis of masonry columns. The macroscopic model is obtained starting from a discrete description of the structure and by imposing a kinematical map (third-order differential expansion) that guarantees a one-to-one correspondence between the set of degrees of freedom of the discrete system and the continuum kinematic vector fields. It is also required that the power of the internal forces of the discrete system and its kinetic energy correspond to the continuum internal density power and kinetic energy density, respectively. Dispersion curves (phase velocities versus wavelength) evaluated for the model show good agreement between both the discrete and continuum models, in a given range of ratios between the wavelengths and size of the elementary cells.

The paper by Aigner, Lackner, and Eberhardsteiner presents a rheological model for the analysis of the time-dependent behavior of asphalt under a high-temperature regime. The behavior of the material in such conditions is obtained extending toward plasticity a purely viscoelastic model previously formulated by the same authors. This is done by introducing a friction element. The viscoelastic and viscoplastic constitutive relationships (inclusive unloading) are obtained using a multiscale procedure that allows the dialog among five observation scales. The constitutive relations at the macroscopic level are suitable for the analysis of flexible pavements in order to capture the main failure mechanisms (rutting, low-temperature cracking, and fatigue). Some numerical analyses are performed using the material parameters identified from a bending-beam rheometer. The comparison with the results of triaxial cyclic compression tests of asphalt in-service conditions in the case of high-temperature loading show satisfactory correspondence.

In the paper by Boso and Lefik the mechanical behavior of materials with a complex geometric internal structure is investigated. Attention is focused on wire ropes made of several bundles of wires arranged according to a hierarchical structure and twisted into strands, such as cables used in magnet technology. The problem of identification of the material terms of the rope related to multilevel helix geometry and to twist pitches, which causes some coupling

effects not accounted for in the classical Euler–Bernoulli beam model, is tackled by resorting to an artificial neural network (ANN) approach. In particular, a multilevel recursive procedure is performed, aimed at substituting a bundle of wires with an equivalent single wire, taking into account the complex geometry and the contact phenomena. The numerical tests affected by using a hybrid finite-element/ANN code allow investigating the influence of twist pitches and of nonlinear contact interactions on the material response.

We hope these research issues will provide opportunities to identify and discuss future developments in the field of multiscale modeling and design of advanced materials. Finally, our special thanks are given to the editor Jacob Fish for his invitation to select and collect papers in a special issue of this journal and for assisting us in the editorial work.

Patrizia Trovalusci
Department of Ingegneria Strutturale e Geotecnica,
Sapienza-University of Rome,
Via Gramsci 53, 00197 Rome, Italy
patrizia.trovalusci@uniroma1.it

Bernhard Schrefler
Department of Ingegneria Civile,
Edile e Strutturale e Trasporti University of Padua,
Via Marzolo 9, 35131 Padua, Italy
bas@dic.unipd.it

REFERENCES

Trovalusci, P., Foreword: Multiscale mechanical modelling of complex materials and engineering applications, *Int. J. Multiscale Comp. Eng.*, vol. **5**, no. 2, pp. vii–ix, 2007.

Trovalusci, P. and Ostoja-Starzewski, M., Foreword: Multiscale mechanical modelling of complex materials and engineering applications 2, *Int. J. Multiscale Comp. Eng.*, vol. **9**, no. 5, pp. vii–ix, 2011.