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Mechanics of High-Contrast Elastic Solids

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(Article begins on next page)

Preface

This volume is an outgrowth of the Euromech Colloquium №626 entitled «Mechanics of High Contrast Elastic Composites», held in virtual format in the period 06-08 September 2021, under the auspices of the European Society of Mechanics. During this event, that attracted 56 participants from 19 countries, it could be noted that a variety of interesting phenomena arises when widely different mechanical properties are cunningly joined together to produce new composite materials. This fruitful meeting paved the way for developing new insight into the diverse and multifaceted realm of engineered materials and the applications thereof. Falling upon these lines, this volume collects 14 papers elaborating the outcome of high contrast from different complementary perspectives, ranging from experimental to numerical results, from analytical investigation to mathematical modeling. The spectrum of the addressed topics is wide in nature, as it moves from the strength of bio-inspired composites to stochastic homogenisation of high-contrast media, while sweeping through delicate aspects in the formulation of boundary conditions arising from a generalisation of the Saint-Venant's principle in strongly inhomogeneous laminates, yet encompassing asymptotically consistent theories of microstructured plates and metamaterials for extreme deformations, etc. As cases in point of the diverse outcomes associated to high contrast, we point to studies on the dynamics of bi-laminated plates with a soft viscoelastic core as well as to novel results concerning engineered aggregates for enhanced dynamic performance of concrete (meta-concrete).

Besides its natural academic interest, the subject matter of this volume is additionally motivated by conspicuous practical applications, among which we mention the development of lightweight structures, of novel biomedical composites and the design of soft robotics, to name only a few. Great emphasis is placed on the development of mathematical models as well as on their extrapolation. In this context, the study of layered structures take paramount importance for it offers great insight into more complex problems, while expressing the most common structure of composite materials. Along this line, the mechanics of layered elastic structures is considered addressing the statics, dynamics and buckling of multi-layered high-contrast plates (C. Boutin). Equally, studies on the delamination between the layers of a three-layered shell (L. Aghalovyan et al) are reported, as well as the use of dispersive analysis to detect the presence of a sandy layer in a stratified half-space (S.V. Kuznetsov). Another important topic covered in this volume is related to the consideration of reinforced materials and structures, featuring a review of

the multiform approaches pursued in the literature (H. Altenbach), as well as consideration of a technical multiple particle inverse problem for fiber-reinforced composites (V. Mityushev et al). One more relevant area of investigation concerns periodic media and, specifically, the study of frequency bands in silver-mean quasicrystalline-generated waveguides (Z. Chen et al), the proposition of tunable porous periodic structures (J. Li et al), a generalisation of the Fourier Law of heat transfer in 1D nonlocal lattices with short and long interactions (E. Nuñez del Prado et al), the calculation of effective properties of multi-phase periodic laminated Cosserat composite by means of a two-scale homogenisation technique (Y. Espinosa-Almeyda et al), and the investigation of the dynamic response of a beam with an attached periodic array of resonators (M. Nieves and A. Movchan). Also, we mention the contributions dealing with finite multi-component structures, including a numerical approach to nonlinear vibrations of stepped beams and frames with high contrast elastic properties (R. Pušenjak and A. Nikonov), a study of localised vibrations in two-component cylindrical panels (G. Ghulghazaryan and L. Ghulghazaryan), and investigation of the snap-through instability of the von Mises two-bar truss (M. Pellicciari et al). Finally, dynamic modelling of silica aerogels is investigated, accounting for micro-structural effects in such highly inhomogeneous lightweight composites (R. Abdusalamov et al). We hope that the enthusiasm and the dedication of these valuable contributions may form an interesting read for the mechanics community.