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2nd International Conference on Theoretical, Analytical and Computational Methods for Composite Materials and Composite Structures (ICOMP2021)

March 5 @ 12:00 am - March 7 @ 12:00 am

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Start:
March 5 @ 12:00 am

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March 7 @ 12:00 am

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« European network for Lightweight Ship Structures

SAMPE UK & Ireland Annual Seminar 2021 »

ICOMP2021
2nd International Conference on Theoretical, Analytical and Computational Methods for Composite Materials and Composite Structures

5-7 March 2021

BOOK OF ABSTRACTS

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heating rate up to 500 °C/min, the grain growth was limited that resulted with enhanced mechanical properties of the obtained bulk material. The grains in the obtained bulk material were 500-700 nm, 5-6 times larger than the particles in the initial nanopowder. However, electroconsolidation at rates 250 °C/min and 50 °C/min resulted with respective grains 30-40 and 60-90 times larger than the powder particles. It is difficult to identify proper mechanisms of the consolidation even in a typical sintering processes despite they are examined for decades. Quick sintering at high heating rates poses additional theoretical problems, since vacancies flow is reduced, large pores are decreased, and grain growth is slowed down. When the porosity at the grain boundaries is quickly decreased, mobility in this area rapidly intensifies. Thus, high rate heating generates two opposite mechanisms. On the one hand, large number of small pores appears, and in the other hand, they provide conditions for the grain growth. The pores become the interference at the grain boundaries and thus grains tend to grow more intensely. During the heating under pressure, physical contact between grains leads to the formation of branched network of boundaries. The free surface energy is consumed by the boundaries formation, while the excessive energy is the main motor of sintering. High heating rate activates the sliding effect along grain boundaries leading to quick densification. Moreover, sintering mechanism is additionally powered by the energy of lattice imperfections, which in case of plasmochemically synthesized nanopowders is substantial. Due to the stresses in the necks of the sintered particles and gradient of vacancies concentration, diffusional displacement of the mass towards necks takes place. Methods for calculation of densification considering volumetric diffusion, as well as diffusion in boundaries and surfaces, allowed determination of the diffusion coefficients based on the experimental data. The results confirmed suggestion that the nanoparticles contained substantial amounts of linear imperfections and dislocations appeared in the contact area between the particles during sintering process under the electrical current and mechanical pressure.

Human femur: evaluation of mechanical strength by limit analysis

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Population aging, especially in the more developed Countries, is an indicator of well-being, nevertheless it poses a number of problems such as, among other, the increasing of bone-related diseases, skeletal fractures and osteoporosis, which affect the health system and have significant economic implications. In the last few decades, several scientific efforts have been made to predict and describe the human bones mechanical behaviour under different loading conditions, see e.g. [1] and references therein. However, the complexity of the bone material depending, in contrast to engineering materials, by several external factors such as age, conditions of growth, type of feeding, environmental and working circumstances, has not allowed scientists to find approaches of general applicability, so that the research in this area is very active. Finding motivation on the above remarks, the present contribution proposes the application, in the above outlined context, of the Limit Analysis Theory, so focusing on the ultimate bone mechanical conditions. A sufficiently accurate and reliable prediction of the peak/collapse load for a human long bone is attained. In particular, a Finite Element (FE) numerical technique, namely the Elastic Compensation Method (ECM), is promoted to address the human femur limit analysis. The ECM is an iterative procedure made of sequences of linear elastic analyses, through which the elastic moduli of the constituent material are systematically varied to simulate the process of stress redistribution arising within the structure suffering an increasing load till the attainment of its strength threshold. The ECM has been applied by the authors in the past to structures made of engineering materials like steel, composites or reinforced concrete [2]. To deal with human bone material, a constitutive model of Tsai-Wu-type in principal stress space is assumed for the human bone [3], the latter is modelled in 3D and viewed, at a macroscopic level, as a structural element made of a composite anisotropic material. The obtained numerical results, even if at an early stage, when compared with the ones present in literature and obtained via experimental findings, [4], encourage the authors to continue the undertaken research.

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Additively Manufactured Foam under Compression

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In current work syntactic foam-based functionally graded material (FGM) is developed using fused filament fabrication (FFF). FGM is printed using lightweight filaments of glass micro balloon (GMB) reinforced high-density polyethylene (HDPE). Flat wise compressive behavior of 3D printed HDPE and syntactic foam-based FGM (0-20-40) are studied as per ASTM standard. Results reveal that the compressive modulus of the FGM is higher compared to neat HDPE with a slight decrease in strength. This is due to induced void content formed during the 3D printing. These voids enhance the weight reduction potential of the foams and help in improving damping and buoyancy properties. The specific modulus and strength of 3D printed FGM are higher compared to neat HDPE. Results of SEM analysis showed that sustainability of filler was good in pre-compression tested samples without any GMB failure which signifies that all the chosen process parameters for printing FGM are appropriate, whereas breakage of GMB filler is observed in post-tested samples.

Keywords: 3D printing; Syntactic foam; Glass micro balloons; Functionally graded material.

Rotational 3D Printing of Carbon Fiber Reinforced Epoxy Composites with Controllable Fiber Orientation

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Carbon fiber reinforced epoxy resin composites play a vital role in application of aerospace, traffic vehicle and lightweight engineering. The composites exhibit exceptional mechanical performance that often arises from complex fiber orientation in the material. Controlling fiber orientation in materials is very challenging. A set of rotary extrusion 3D printing equipment was built to change fiber orientation. Using this equipment, orientation of short fibers in the printing trajectory can be