GUEST EDITORIAL

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The International Symposium on Dynamic Response and Failure of Composite Materials, Draf2018

This special issue of JMEP is dedicated to the “International Symposium on Dynamic Response and Failure of Composite Materials, Draf2018” that was organized in Ischia, Naples, from June 12, 2018, to June 15, 2018. It contains selected papers presented at Draf2018 by scientific delegates from international universities and research centers, dealing with current research topics on composite materials and sandwich structures under dynamic loading conditions.

This was the symposium’s third annual event. Its primary objective is to gather people from different universities, research centers, and industries all over the world to discuss research of useful and innovative solutions to solve the problem of the response of composite materials under severe loading conditions. The final aim is to promote interaction and collaboration between scientists involved in the same topic.

The attention is focused on marine applications because of the involvement of the Solid Mechanics Program (SMP) of the Office of Naval Research (ONR, USA). SMP focuses on dynamic failure of composite and sandwich structures for naval applications. Dr. Yapa D.S. Rajapakse, program manager at ONR and member of the Scientific and Organizing Committee of the conference, opened the sessions with interesting plenary lectures on research needs in this field. In 2018, the ONR Special Session was organized and chaired by Prof. M. Porfiri from NYU.

Applications in aerospace were also discussed in an interesting Aerospace Session opened by an astronaut of the Italian Air Force, Lieutenant Walter Villadei, with a plenary lecture on future challenges in the space domain.

Failure modes, failure criteria, constitutive equations, and damage investigations from experimental, theoretical, and numerical points of view were discussed also in order to provide useful tools for material and method selection to fabricate and design advanced structures in the aforementioned fields. Automotive applications were discussed. Structure/fluid interaction, wave/hull slamming, explosion and implosion, extreme loading conditions, structural health monitoring, and cold spray techniques in the field of composites are emerging as new areas of interest.

The present special issue reflects the main topic of the conference: highlighting the effects of foreign object impacts at low and high speed, explosions and crashes with applications to aircraft crash landings, road vehicle crashes, hull slamming of ships, both in-air and underwater explosions of composite materials, and sandwich structures. Most of the attention is dedicated to the crucial problem of damage, which is difficult to investigate because of the anisotropic nature of the materials under study. Building on the extensive literature on the topic, this special issue presents a collection of selected papers that represent recent advances in a field seeing great advances because of improved computational capabilities, new materials, and new testing facilities. Each manuscript contains original contributions by the authors resulting in a clear view of the current state of the art in a specialized research field.

In the following, the content of each presented manuscript highlights the single contribution in terms of novelty to the main topic of the conference.

A. Shukla in “Effect of Prolonged Ultraviolet Radiation Exposure on the Blast Response of Fiber Reinforced Composite Plates” presents recent studies on the implosion of double-hull composite cylinders, sandwich composite cylinders, and sympathetic implosion of neighboring composite cylinders under hydrostatic loadings. Experiments are conducted to study the mechanics of implosion of carbon composite cylindrical tubes in an open field environment. The 3D-DIC technique was utilized in conjunction with high-speed photography to obtain quantitative information on the deformation of the composite tubes. It is very impressive research with very interesting results.

A. Astarita et al. in “Manufacturing of a Metal Matrix Composite Coating on a Polymer Matrix Composite through Cold Gas Dynamic Spray Technique” demonstrate that cold spray technology, which allows for the creation of powder-based coatings by spraying particles at high speed and relatively low temperatures, shows enormous potential when used with composite and polymeric substrates, giving the possibility to overcome their weaknesses. In particular, the potential of using different mixtures of metal/ceramic powders (Al and Al_2O_3 particles were chosen for the purpose) was examined for the first time, and the authors succeeded in obtaining coatings with improved surface properties and tribological characteristics. This was not done before in the literature, and in general, the application of the technology in the field of composite materials has not been investigated yet.

V. Memmolo et al. in “Experimental and Numerical Investigation of PZT Response in Composite Structures with Variable Degradation Levels” inspect piezoelectric transducers adopted for structural health monitoring of composite structures by the electromechanical impedance technique. The authors investigate different modes of impact failure via measurements and numerical simulations. The virtual environment is further employed to look into the sensor response under different degradation levels. The combined mode of failure is assessed as the most critical impact-induced damage.

The article “Interaction of Guided Waves with Delamination in a Bilayered Aluminium-Composite Pressure Vessel” by Parodi et al. deals with the propagation of Lamb waves in a bi-layered pressure vessel designed for space application. They are studied in view of structural health monitoring. Space debris may induce random impacts threatening the connection between aluminum and composite parts. Measurements are adopted to characterize the dispersion behavior of guided waves. Instead numerical models are validated to enhance simulation efficiency. Finally, the virtual environment is employed to further look into the interaction of propagating waves at the debonding.

R. Scazzosi, A. Manes, and M. Giglio in “Analytical Model of High-Velocity Impact of a Deformable Projectile Against Textile-Based Composites” present analytical models for high-velocity impact on textile-based composites exploiting wave propagation theory and an energy equilibrium approach. The novelty is the assumption of a rigid projectile and the erosion and the deformation of the projectile added to the formulation. The main limitation of the models from the literature is the assumption of a rigid projectile, which leads to the underestimation of the ballistic limit for soft-core projectiles, which are a very common type of threat for this kind of protection. The present model has been proved to deliver more accurate results especially in the estimation of the ballistic limit. The model indeed accounts for projectile deformation, which plays an important role in the dissipation of the kinetic energy of the projectile, especially close to the arrest phase that is the condition of the ballistic limit.

P. Russo et al. presented the paper “Impact Damage Behavior of Vinyl Ester-, Epoxy-, and Nylon 6-Based Basalt Fiber Composites.” The focus of the work is on the low-velocity impact behavior of composite laminates based on three different polymer matrices, reinforced with woven basalt fibers. With the aim of highlighting potentials of intrinsically recyclable thermoplastic systems with respect to thermosetting ones, the latter largely used for advanced applications, the authors compared samples made by polyamide 6 with laminated structures based on traditional epoxy and vinyl ester resin. Moreover, basalt fibers are new natural fibers with high potential not yet investigated in depth. A significant aptitude to withstand impact loadings was manifested by polyester–basalt composite coupling.

M. Ferraiuolo and A. Riccio presented the paper “Study of the Effects of Materials Selection for the Closeout Structure on the Service Life of a Liquid Rocket Engine Thrust Chamber” focused on the investigation of the impact of advanced materials selection on the performance of the thrust chamber with the aim of avoiding fatigue crack initiation and subsequent catastrophic failure. The external structure of rocket engine thrust chambers for aerospace applications should be designed in order to provide adequate stiffness to the thrust chamber, which is subjected to severe dynamic thermostructural loads.

M. R. Ricciardi et al. worked on “Impact Behavior of Polyester GFRP for Naval Applications: Influence of the Clamping Device and Fluid–Material Interaction.” The paper aims to understand the effect of exposure to liquids on low-velocity impact behavior of polyester glass fiber composite laminates. The topic is novel and ambitious, focusing also on the implementation of a proper experimental setup for impacts in the presence of fluids. Results evidence the need of taking into account the fluid–structure

interaction in the design of composite materials for marine applications due to the different mechanisms of load distribution, impact energy absorption, and deflection for specimens exposed to liquids with respect to air impacted laminates.

M. Viscardi et al. in “Manufacturing and Validation of a Novel Composite Component for Aircraft Main Landing Gear Bay” present some relevant outcomes concerning the design of a composite sample for the main landing gear bay of a large commercial airplane (EASA CS25), achieved within the InTEgrated Full Composite Main Landing Gear Bay Concept (ITEMB) project, a program of the Clean Sky 2 EU research framework. The most ambitious goal of the project is represented by the development of a new type of lower center fuselage (LCF) with an innovative integrated landing system, which is considered the next frontier in the development of landing systems for medium-haul aircraft, such as the Airbus A320 aircraft family. The development of a different architecture, with the landing gear integrated within the related fuselage bay, could lead to a simplification of the whole subassembly with potential advantages in terms of construction and assembly times. The main results of the work are presented, introducing the novel design architecture, the main processing steps, and prototype results achieved.

S. Saputo et al. in “Crashworthiness of a Composite Wing Section: Numerical Investigation of the Bird Strike Phenomenon by Using a Coupled Eulerian–Lagrangian Approach” introduce a numerical investigation on a wing section subjected to a high-velocity impact representative of a bird strike phenomenon. The wing is made of unidirectional carbon fiber composite material. In order to numerically simulate the bird strike phenomenon on the composite wing, a three-dimensional modeling of the impacted structure was introduced. The arbitrary Eulerian–Lagrangian approach was used to numerically simulate the impact, taking into account the effects of the Eulerian bird on the Lagrangian structure. The mechanical and damage behavior of the wing section was investigated by considering different impact angles and positions of the bird with respect to the wing leading edge.

“Experimental Study of the Influence of a Tensile Preload on Thin Woven Composite Laminates Under Impact Loading” was presented by T. Langella from University of Naples in a collaboration with the Institute Clément Ader of the University of Toulouse. The influence of a tensile preload on the impact behavior of thin woven composite laminates is investigated. It deals with composite materials in carbon/epoxy and glass/epoxy mixed configurations used for helicopter blades generally subjected to centrifugal force during flight, resulting in a tensile prestress of the skin, and to external loads like impacts in “in service” operations. This study identifies a correspondence between the preload and the resulting impact damage and develops a representative numerical model of material behavior. Experimental tests are carried out on thin laminates and on sandwich structures. The samples are uniaxially loaded using a special test rig available at University of Toulouse. The effect of the preload on the impact damage is experimentally quantified and discussed. The numerical and experimental results are compared with success.

V. Pagliarulo in “Impact Damage Investigation on GFRP Laminates at Room and Lower Temperature: Comparison between US and ESPI Technique,” worked on an innovative nondestructive technique to investigate the delamination caused by low-velocity impact tests at different impact energy values and different temperatures, on glass fiber composite laminates (GFRP). Electronic speckle pattern interferometry (ESPI) is a well-established optical technique that allows the measurement of displacements, strains, defects, and cracks on rough surfaces with high sensitivity (related to the wavelength) and belongs to the family of coherent light interferometry techniques that also includes the shearography. This technique enables the measurement of displacements in real time and in full-field modality, without direct contact with the object through surface illumination by laser. The results were compared with the largely used ultrasound technique: good agreements were found. Crushing of laminated composites is the result of a combination of several and complex failure mechanisms, which are not always possible to reproduce together in a single finite element analysis.

In “Sensitivity Analysis of Material Model Parameters to Reproduce Crushing of Composite Tubes,” S. Boria et al. use models based on lamina-level failure criteria to predict the onset of damage; MAT_ENHANCED_COMPOSITE_DAMAGE (MAT_54) was chosen for modeling the axial crushing of truncated conical thermosetting composite structures given its ability to reproduce the crushing phenomenon with a reduced number of input parameters inserted into the card definition. Comparison with experimental data confirmed the efficiency of such a material model. The novelty is that real deformation mechanisms were also captured, which was not possible with the previous material modeling.

I. Papa et al. in “Interaction of Water with Carbon Fiber Reinforced Polymer Laminates under Dynamic Loading Conditions” worked with the aim of simulating the real conditions under incidental dynamic loadings during navigation in the Arctic Ocean. The latter can be caused by ice, by a projectile due to a terrorist attack against military ships, or by debris from an explosion. Impact tests were performed by loading carbon fiber laminates into a vinyl ester matrix because of the lower moisture absorption compared to the other epoxy systems, immersed in water from the front side, or supported by a thick layer of water. The results were compared with the ones obtained in traditional impact tests in air. The important role played by the complex fluid–structure interaction was highlighted.

Added value was given by M. Shitikova, who dedicated her presentation “Wave Theory of Impact and Professor Yuri Rossikhin Contribution in the Field (A Memorial Survey)” to the bright memory of Professor Yuri A. Rossikhin, who contributed much to the development of the wave theory of impact based on the theory of discontinuities and ray expansions, resulting in analytical solutions

of intricate problems of impact interaction of solids possessing different features. The author contributes with an overview of the impact response of solids and structures within the framework of the wave theory of impact.

The chairpersons of the conference are grateful to all the participants.

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