Guest Editor's Note

Ahmad Varvani-Farahani

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Current research activities in composite materials provide some insight into technologies that will mature toward practical application in both the short and long terms. While modern composites are in their early stage of progress, there is several worldwide ongoing research themes which are defined based on emerging technological challenges in characterization, fabrication and application plotting the outlook and future directions in research of this class of materials. Crucial research themes are yet to fully address nano-composites/nano-phase reinforcements, multifunctional composites/structures with self-assessment and self-repair capacity, shortening design cycle for the exploration of various design concepts at reduced costs, bio-composites for implants, technology innovations leading to new and improved composite materials, composite materials resources and restrictions, sustainability of composite resources recyclability and environmental issues, development of nondestructive inspection (NDI) that can reliably measure durability of composites, developing composites with higher resistance at elevated temperature, corrosion, wear and impact, generation of pertinent data bank and information on various aspects of composites.

The second International Conference on Composites: Characterization, Fabrication and Application (CCFA-2) held in Kish Island on December 2010 was organized to bring together both engineers and researchers in the field to discuss the latest research challenges in composites as well as future research outlook and directions. The CCFA-2 addressed several advanced research topics in the field through over 250 presented articles in both forms of oral and poster.

The present special issue contains peer-reviewed selected papers presented at CCFA-2 conference. The following section briefly highlights papers appeared in the current special issue in the journal of Applied Composite Materials. Of the nine articles published in this issue, an article examines nonlinear viscoelastic response of unidirectional polymeric laminated composite plates under bending loads, one is on the approximate formulation of composite multi-layered tubes with non-circular cross-sections subjected to torsion, one

A. Varvani-Farahani (✉)
Department of Mechanical & Industrial Engineering, Ryerson University, 350 Victoria Street, Toronto,
Ontario M5B 2K3, Canada
e-mail: avarvani@ryerson.ca

investigates experimentally and numerically mixed-mode fracture of carbon/polyester laminated composite using an Arcan set-up, one is on damage detection in composite plates by means of modal analysis and artificial intelligence methods, two are on dynamic stability and vibration analysis by means of finite element and optimization approaches, one is on the fatigue damage progress in FRP composite laminates based on stiffness degradation while another is on the progressive damage between the composite patch and aluminum panel under fatigue cycles, and one is to simulate the time dependent pultrusion process of glass/polyester composites.

On the viscoelastic response of polymeric laminated composite plates under bending loading, Falahatgar and Salehi employed a simplified unit cell micromechanical method (SUCM) to evaluate overall behavior of the unidirectional composite for various loading conditions. They utilized finite difference dynamic relaxation (DR) method to study the bending behavior of Mindlin annular sector plate including geometric nonlinearity under uniform lateral pressure with clamped and hinged edge constraints. The deflection results of viscoelastic laminated sector plate were presented for various fiber volume fractions in the composite system.

Bazehhour and Rezaeepazhand formulated composite tubes with multi-layered non-circular cross-sections under torsion based on Bredt's theory. Layers were taken isotropic with different thicknesses and material properties. They reported that depending on the properties of the layers, maximum shear stress does not necessarily happen on the outer boundary. The effect of different cross-sectional shapes under torsion was further studied. The proposed formulation was found capable of solving FGM tubes subjected to torsion and suitable to be implemented for optimization programs.

Choupani, Heydari and Shameli investigated mixed-mode fracture toughness in carbon/polyester composite by means of numerical and experimental methods. Fracture toughness tests were performed by Arcan set-up. Mode I, mixed-mode and Mode II fracture data were obtained as loading angle varied from 0° to 90° with an interval of 15° . The j-integral method was employed to describe the mixed-mode stress intensity factors at the crack tip under different loading conditions. They reported the greater interlaminar fracture toughness in the shearing mode as compared with that of the opening mode. They attributed this to the fact that the interlaminar cracked specimen is tougher in the shear loading condition and weaker in the tensile loading condition.

A composite plate on vibration was examined by Nasiri, Mahjoob and Aghakasiri to detect and localize delamination based on the frequency response and modal analysis. Damage detection method was found to be advantageous over other traditional methods due to its non-destructive nature. They introduced more testing parameters as the input data in an artificial intelligence scheme to further characterize damage severity.

Extensional-torsional coupled vibration in nonuniform composite beams was studied using a dynamic finite element (DFE) technique. Hashemi and Roach employed the Galerkin weighted residual formulation and the dynamic stiffness matrix (DSM) method. Assembly of the element matrices and the application of the boundary conditions resulted in a frequency-dependent nonlinear eigenproblem, which was solved to evaluate the system natural frequencies and modes. They reported the correctness of the theory and the superiority of DFE results over DSM and the conventional finite element results.

Dynamic stability and design optimization of laminated simply-supported composite plates under planar conservative boundary loads were investigated by Shafei and Kabir. An optimum design consisted in a maximum stability load satisfying a predefined stable vibration frequency. The interaction between compound loading and layup angle parameter affected the order of merging the vibration modes and stabilizing the dynamic response.

The results were verified by FE method and stability zones of original and optimized plates were stated as final data. Presented method intended to help designers to stabilize the dynamic response of composite plates by selecting an optimized layup orientation and thickness.

A stiffness-based fatigue damage model was developed by Ahmadzadeh, Shirazi and Varvani-Farahani to characterize damage progress in CFRP [90/±45/0] composite laminates. The damage model was constructed based on cracking mechanism and damage progress in matrix, matrix-fiber interface and fiber. Experimental fatigue damage data of CFRP [90/±45/0] composite laminates have fell between the predicted damage curves of 0°, 90° plies and ±45°, 0/±45° laminates over fatigue life cycles at various stress levels. The proposed model accumulated damages of constituent plies constructing [90/±45/0] laminates by means of weighting factor η_{90} , η_0 and η_{45} . Effect of layup sequence on the damage model was assessed and the proposed fatigue damage model successfully recognized the changes in mechanism of fatigue damage progress in composite laminates.

Hosseini-Toudeshky, Jasemzadeh and Mohammadi studied the initiation and delamination growth in the adhesive layers of the repaired aluminum panel by composite patches under fatigue loading. A three-dimensional finite element method with a thin layer solid-like interface element was employed for the analysis of crack growth in aluminum panel and mixed mode debonding growth in the adhesive layer. A user element routine and a damage model routine were developed to include the interface element and to simulate the crack initiation damage progress in adhesive layers under cyclic loading. They reported that the debonding propagation and crack growth rate of the repaired panels very much depend on the composite patch material and the interface bonding properties.

Shokrieh and Aghdami employed a dynamic transient analysis to simulate the time-dependent pultrusion process of glass/polyester composites. The analysis enabled a systematic simulation of the resin curing process. The resin curing process consisted in two liquid and gel-solid phases. Physical properties of the resin such as resin specific heat, viscosity and thermal conductivity were affected as the resin temperature and the degree of cure varied. Since the physical and mechanical properties of fibers stayed unchanged during the curing process of composites, an equivalent homogenous material was replaced with the resin-fiber compound. The dynamic transient analysis successfully simulated the heat generation during the resin curing process as well as the pultrusion process.

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