

# ICCS25

25th International Conference on Composite Structures

Faculty of Engineering, University of Porto, Portugal

19-22 July 2022

## Book of Abstracts

António J.M. Ferreira

Nicholas Fantuzzi

Michele Baccocchi

Volnei Tita

Ana Neves



# Welcome Address

The abstracts collected in this book represent the proceedings of the conference ICCS25 (25th International Conference on Composite Structures) , 19-22 July 2022. This book aims to help you to follow this Event in a timely and organized manner. Papers are selected by the organizing committee to be presented in virtual/physical format. Such arrangement is due to the effects of the coronavirus COVID-19 pandemic. The event, held at FEUP-Faculty of Engineering, University of Porto (Portugal), follows the success of the first 24 editions of ICCS. As the previous ones, this event represents an opportunity for the composites community to discuss the latest advances in the various topics in composite materials and structures.

---

## Conference chairs

*António J.M. Ferreira, University of Porto, Portugal*

*Nicholas Fantuzzi, University of Bologna, Italy*

*Michele Baccocchi, University of San Marino, San Marino*

*Volnei Tita, University of São Paulo, Brazil*

*Ana Neves, University of Porto, Portugal*



# Contents

<b>Welcome Address</b>	<b>iii</b>
<b>Abstracts</b>	<b>1</b>
<b>Additive Manufacturing</b> . . . . .	<b>1</b>
Bending behavior of additively manufactured SiC multilayered composites with porous structure ( <i>Zhijuan Zhong; Tao Zeng; Xiaotong Pan; Jianhua Wen; Siwen Yu</i> )	1
Investigation of the energy absorption capacity of hybrid three-dimensional lattice structures ( <i>Gharehbaghi, Hussain; Farrokhhabadi, Amin</i> ) . . . . .	1
EFFECTS OF FIBER DISTRIBUTION AND HEAT TREATMENTS ON THE OUT-OF-PLANE BEHAVIOR OF 3D PRINTED CONTINUOUS FIBER-REINFORCED THERMOPLASTICS ( <i>Carlos Medina; Rodolfo Hermosilla; Andres de la Fuente; Alexis Salas; Manuel Melendrez</i> ) . . . . .	2
EM-absorbing structure with lightning strike protection using 3D printing reinforced method ( <i>So-Mang Hong; Van-Tho Hoang; Jin-Hwe Kweon</i> ) . . . . .	2
Fabrication of Thermoplastic based fibre Composites on 3D Printed Substrate using Infrared based Automated Fibre Placement ( <i>Venkatesan, Chadurvedi; Mohammad Faiz; Muhammad Rhidwan; Arlindo Silva</i> ) . . . . .	3
Thermoplastic coating on fiber reinforced polymer composites by cold spray additive manufacturing ( <i>Anni, Ibnaj Anamika; Kaminskyj, Madison; Uddin, Kazi Zahir; Bacha, Tristan; Singh, Nand Kishore; Stanzione, Joseph; Haas, Francis; Koohbor, Behrad</i> )	3

Two level homogenisation strategy for identification of thermal properties of composites obtained through additive manufacturing techniques ( <i>Catapano, Anita; Izzi, Michele Iacopo; Aufiero, Simone; Sommier, Alain; Pradere, Christophe; Montemurro, Marco</i> ) . . . . .	4
<b>Advanced Numerical Techniques</b> . . . . .	6
Nonlinear responses of bi-stable laminates with simply supported at four corners under impact loads ( <i>Y.X. Hao</i> ) . . . . .	6
Dynamic response of a sandwich structure with thick-section core in thermal environments with general boundary conditions using variational asymptotic method ( <i>Li, Jinming; Liu, Liu</i> ) . . . . .	6
Multiscale isogeometric analysis of thick sandwich structures using refined zigzag theory ( <i>Kheyabani, Aryan; Massarwa, Eyass; Kefal, Adnan</i> ) . . . . .	6
Experimental and Numerical Failure Analysis of Thin-Walled Composite Plates Using Progressive Failure Analysis ( <i>Falkowicz Katarzyna; Rozylo Patryk; Samborski Sylwester; Debski Hubert</i> ) . . . . .	7
A ps-FEM approach for the analysis of laminated shells ( <i>Yan, Cheng Angelo; Vescovini, Riccardo</i> ) . . . . .	7
Research on the resistance of an orthotropic composite to the pressures caused by mechanical fasteners ( <i>Zakaszewska, Angelika; Godzimirski, Jan; Komorek, Andrzej</i> )	8
HOHWM for vibration, bending and buckling analysis of composite and nanostructures ( <i>Majak, Jüri; Mehrparvar, Marmar; Arda, Mustafa</i> ) . . . . .	9
Prediction of stress-strain behavior of fiber-reinforced woven composites via deep neural network ( <i>Dug-Joong Kim; Jeong-Hyeon Baek; Hak-Sung Kim</i> ) . . . . .	9
Feasibility study of a jib crane using steel, aluminium and two composite materials. ( <i>Solazzi, Luigi; Vaccari, Marco</i> ) . . . . .	10
Numerical analysis of bridged-crack in concrete ( <i>Upnere Sabine</i> ) . . . . .	10
Non-ordinary state-based Peridynamics for fracture analysis of functionally graded structures ( <i>Vieira, Francisco; Araujo, Aurelio</i> ) . . . . .	11
HOHWM for solving fractional differential equations. Applications to composite structures ( <i>Mehrparvar, Marmar; Majak, Jüri; Arda, Mustafa; Karjust, Kristo</i> ) . . . .	11

Prediction of Transverse Permeability of Unidirectional Fiber Reinforced Composites with Electric-Hydraulic Analogy ( <i>Bae, Sangyoon; Jo, Hyeonseong; Kim, Seong Su</i> ) . . . . .	12
Influence of post-consolidation to remove void content on material properties of continuous carbon-fibre reinforced additively manufactured specimens in tensile and bending testing ( <i>Sieberer, Stefan; Savandaiah, Chethan; Schagerl, Martin</i> )	12
A meshless crack propagation algorithm extended to mode II loading of adhesive joints ( <i>Gonçalves, Diogo; Sánchez-Arce, Isidro; Ramalho, Luís; Campilho, Raul; Belinha, Jorge</i> ) . . . . .	13
Modeling Crash Safety of Lithium Batteries, from Electrodes to Battery Packs ( <i>Sahraei, Elham; Gilaki, Mehdi</i> ) . . . . .	13
Establishing properties of the SVE boundary in computational homogenization of random media. ( <i>Wojciechowski, Marek</i> ) . . . . .	14
Numerical and experimental studies of the influence of curing and residual stresses on buckling in thin-walled, CFRP square-section profiles ( <i>Paweł Czapski</i> ) . . .	14
GEOMETRICALLY EXACT FINITE-ELEMENT ANALYSIS FOR MICROSTRUCTURED COMPOSITE AS COSSERAT CONTINUUM ( <i>Shi, Farui; Fantuzzi, Nicholas; Li, Yong; Trovalusci, Patrizia; Wei, Zuoan</i> ) . . . . .	14
<a href="#">Analysis of Wood and Natural Fibre Composites</a> . . . . .	16
Numerical modelling of bending properties of 3D-printed biocomposites ( <i>Zarna, Chiara; Chinga-Carrasco, Echtermeyer, Andreas T.</i> ) . . . . .	16
Novel hybrid polymer adhesives for laminated materials based on hardwood ( <i>Holeček, Tomáš; Sikora, Adam; Cvejn, Daniel; Mitterpach, Jozef; Šedivka, Přemysl; Lexa, Martin; Niemz, Peter; Sandberg, Dick; Žóltowska, Sonia</i> ) . . . . .	16
Mechanical characterization and modelling of poplar plywood. ( <i>PEIGNON Axel; CASTANIE Bruno; EYMA Florent; CANTAREL Arthur; SERRA Joel</i> ) . . . . .	17
<a href="#">Applications of Composites</a> . . . . .	18
Strengthening of RC Beams using SRG: Effect of Flexural SRG Strengthening on the Shear Contribution of Concrete ( <i>Wakjira, Tadesse; Ebead, Usama</i> ) . . . . .	18

Evaluation of the effect of different physiotherapy activities on 45o tibial oblique fracture when fixed with composite and metallic implant ( <i>Zaheer, Usama; Chang, Seung Hwan</i> ) . . . . .	18
Amine functionalized multi-walled carbon nanotube/hydrogen-rich benzoxazine nanocomposites for cosmic radiation shielding with increased mechanical properties and resistance to space environment ( <i>Ji-Hun Cha; Chun-Gon Kim</i> ) . . . . .	19
A CFRP/GFRP hybrid composite support for double-wall LNG pipe system ( <i>Hong, Hyunsoo; Kim, Woe Tae; Kim, Seong Su</i> ) . . . . .	20
FRCM confinement as a repair technique for seismically damaged RC columns ( <i>Toska, Klajdi; Hofer, Lorenzo; Faleschini, Flora; Zanini, Mariano Angelo; Pellegrino, Carlo</i> ) . . . . .	20
Comparison of carbon fiber recycling methods and the effect of different nano reinforcement into the integrity of the recovered fibers. ( <i>Alexis Salas; Elizabeth Berrio; Andres Diaz; Daniel Palacio; Carlos Medina; Manuel Melendrez</i> ) . . . . .	20
Axial compressive behaviour of FRP-confined seawater sea-sand concrete with recycled FRP bars as coarse aggregate ( <i>Gao, Ze Yu; Zhang, Shi Shun; Nie, Xue Fei; Li, Shan</i> ) . . . . .	21
Influence of composite patch thickness on pipe repair and their relationship to failure pressure ( <i>Reis, J.M.L.; Costa, A.R.; da Costa Mattos, H. S.</i> ) . . . . .	22
<b>Auxetic materials and structures</b> . . . . .	23
Design and tests on modified 3D auxetic structures ( <i>Wang, Suian; Wu, Nan</i> ) . . . . .	23
Auxetic Tubular Structures: Opportunities and Challenges ( <i>Ren, Xin; Zhang, Xiang Yu; Luo, Chen; Han, Dong</i> ) . . . . .	23
<b>Beam, Plate and Shell Theories and Computational Models for Laminated Structures</b>	24
Higher order theories for the static and free vibration analysis of doubly-curved shells of innovative materials enforced with general boundary conditions ( <i>Viscotti, Matteo; Dimitri, Rossana; Tornabene, Francesco</i> ) . . . . .	24
A-posteriori evaluation of transverse stress components in beams, plates and shells ( <i>Augello, Riccardo; Carrera, Erasmo; Pagani, Alfonso; Scano, Daniele</i> ) . . . . .	24



Free vibration analysis of arbitrary laminated composite and sandwich shells via a meshless formulation and FSDT ( <i>Chen Wei; Chen Si Ya; Teng Xiao Dan; Peng Lin Xin</i> ) . . . . .	25
Finite deformation analysis of laminated shell via the discontinuous Galerkin method ( <i>Guarino, Giuliano; Milazzo, Alberto</i> ) . . . . .	25
A theoretical model to investigate the buckling/stress-failure competitive behavior of laminated plates under compression-shear combined loads ( <i>Pian, Rong; Liu, Fengrui; Zhao, Libin; Wang, Linjuan</i> ) . . . . .	26
Global buckling behavior of sandwich beam with graded lattice core ( <i>He Zhang; Tao Zeng; Guodong Xu</i> ) . . . . .	26
Buckling and Vibration Behaviour of the Debonded Stiffened Hygrothermally Stable Laminated Composite Panel Under the Influence of Non-Uniform Edge Loads. ( <i>Kalgutkar, Akshay Prakash; Banerjee, Sawik</i> ) . . . . .	27
A new mixed model based on the enhanced-Refined Zigzag Theory for the analysis of thick multilayered composite plates ( <i>Sorrenti, Matteo; Gherlone, Marco</i> ) . . . . .	27
Numerical stability analysis of composite beam-type structures considering coupled shear deformation effects ( <i>Turkalj, Goran; Banic, Damjan; Lanc, Domagoj</i> ) . . . . .	28
Multilayered Beams, Plates and Shells Elements based on Jacobi Polynomials ( <i>Scano, Daniele; Augello, Riccardo; Carrera, Erasmo; Pagani, Alfonso</i> ) . . . . .	29
<b>Composite Structures</b> . . . . .	30
Vibration reduction on functionally graded beams using linear and nonlinear tuned mass damper ( <i>G.G. Sheng</i> ) . . . . .	30
Viscoelastic vibration of graphene reinforced nanocomposite curved panels ( <i>Karami, Behrouz; Ersoy, Hakan; Civalek, Ömer</i> ) . . . . .	30
Effects of different nanomaterials and steel fibres on compressive and splitting behaviour of ultra-high performance concrete ( <i>Jian-He Xie; Kun-Hong Huang; Yuan Feng</i> ) . . . . .	31
On the dynamics of nanocomposite skew plates resting on point supports ( <i>Žur, Krzysztof Kamil; Kiani, Yaser; Ferreira, Antonio J.M.</i> ) . . . . .	31
Micro-macro modelling of laminated composite reservoir ( <i>Kormanikova, Eva; Kotasova, Kamila</i> ) . . . . .	32

On the wave dispersion characteristics in functionally graded porous nanobeams ( <i>Faghidian, S. Ali; Żur, Krzysztof Kamil; Reddy, J.N.; Ferreira, A.J.M.</i> ) . . . . .	32
Investigation on various section GFRP profile strengthening concrete-filled GFRP tubular columns ( <i>Zhang, Xiaoyong</i> ) . . . . .	32
Behavior of square GFRP tube filled with seawater and sea sand concrete beam ( <i>Zhang, Xiaoyong; Xu Zhijun; Yao Zhu; Wenyuan Kong; Xiang Lin; Chao Zhang; Yu Chen</i> ) . . . . .	33
Axial crushing after aggressive environmental aging of GFRP composite tubes ( <i>Sebaey, Tamer</i> ) . . . . .	33
Test and numerical analysis of 7021-T6 high strength aluminum alloy channel embedded in reinforced concrete structure ( <i>Zhang, Xiaoyong; Chen, Yu; Feng, Gang</i> ) . . . . .	34
Surface quality after milling of II and III-layer hybrid sandwich structures ( <i>Doluk, Elżbieta</i> ) . . . . .	34
The critical state of laminate plates with cut-out and asymmetric layer lay-out ( <i>Wysmulski Pawel; Falkowicz Katarzyna; Debski Hubert</i> ) . . . . .	34
Study on mechanical behavior of pultruded GFRP columns in axial compression ( <i>Yao Zhu; Xiaoyong Zhang; Wenyuan Kong; Yu Chen</i> ) . . . . .	35
Assessment of chemical resistance of low density polyethylene modified with nat- ural filler. ( <i>Głogowska, Karolina; Pączkowski, Przemysław</i> ) . . . . .	35
THE BEHAVIOR OF MULTI BOLTED CONNECTION IN PULTRUDED GFRP: ON STRENGTHENING BY GLASS FIBER SHEETS ( <i>Tran Quang Duc; Phan Viet Nhut; Matsumoto Yukihiko</i> ) . . . . .	36
MODELLING OF THE EFFECT OF THE MICROSTRUCTURE SIZE ON VI- BRATIONS OF PERIODIC SLENDER BEAMS ( <i>Jędrysiak, Jarosław</i> ) . . . . .	36
A BI-AXIALLY ZERO POISSON'S RATIO MORPHING SKIN SYSTEM ( <i>Kölbl, Michael; Ermanni, Paolo</i> ) . . . . .	37
Investigation of bond strength and laminate quality of fibre-metal laminate made of laser-structured Aluminium sheet and CFRP reinforcement ( <i>Wu, Shuang; Delp, Alexander; Freund, Jonathan; Haubrich, Jan; Tröster, Thomas; Walther, Frank</i> ) . . . . .	38

The hydro-mechanical behaviour of biaxial woven fabric-reinforced Composites:	
Effect of weaving patterns ( <i>CHILALI, Abderrazak</i> ) . . . . .	38
Stochastic perturbation-based finite element model for structural responses of the	
graded composite structures with random material properties ( <i>Amir, Mohammad; Talha, Mohammad; Kim, Sang-Woo</i> ) . . . . .	39
Compression after impact behavior of STF-impregnated fabric composite sub-	
jected to low-velocity impact ( <i>Lim, Jaehyeong; Kim, Sang-Woo</i> ) . . . . .	39
On crashworthiness behaviors of 3D printed multi-cell filled thin-walled struc-	
tures under extreme temperature conditions ( <i>Yisen Liu; Kui Wang; Jin Wang; Jiangyang Xiang; Yong Peng</i> ) . . . . .	40
Drop reliability of Sn-MWCNT composite solder with IPL soldering ( <i>Kang, Dong-</i>	
<i>Gil; Noh, TaeJun; Jung, SeungBoo</i> ) . . . . .	40
Hybrid geometry projection method for additively manufactured fiber-reinforced	
composite laminate ( <i>Gandhi, Yogesh; Minak, Giangiacomo; Aragón, Alejandro; Norato, Julian A.</i> ) . . . . .	41
Structural Analysis of a Temporary Shelter with Shape Memory Effect ( <i>Silva,</i>	
<i>Ana Rita; Parente, Marco; Marques, António T.; Areias, Bruno; Rangle, Bárbara; Alves, Fernando J. Lino; Costa, Alice; Figueiredo, Miguel; Esteves, José Luís</i> ) . . . . .	41
Study of structural features and electric conductivity in bi-metallic composite	
conductors ( <i>Kocich, Radim; Kunčická, Lenka; Kačor, Petr</i> ) . . . . .	42
Theoretical Model for Novel FRP-UHPC Hybrid Bars ( <i>Yu-Yi Ye; Jun-Jie Zeng</i> ) . . .	42
Mainshock-aftershock Seismic Performance of GFRP-jacketed RC Bridge Piers:	
Experimental and Numerical Studies ( <i>Hossain, Md. Mosharef; Wakjira, Tadesse G.; Alam, M. Shahria</i> ) . . . . .	43
Effects of clearance fits on composite single lap bolted joints ( <i>Singh, Baij Nath;</i>	
<i>Ranjan, Vinayak; Hota, R.N.</i> ) . . . . .	43
Axial Compressive Behavior and Model Assessment of FRP-confined Seawater	
Sea-sand Concrete-Filled Stainless Steel Tube Stub Columns ( <i>Jun-Jie ZENG; Jinjing Liao</i> ) . . . . .	43

Effects of high pulling speeds on mechanical properties and morphology of pultruded flat laminates ( <i>Vedernikov, Alexander; Gemi, Lokman; Madenci, Emrah; Özkuluç, Yasin Onuralp; Yazman, Şakir; Bondareva, Julia; Evlashin, Stanislav; Akhatov, Iskander; Safonov, Alexander</i> ) . . . . .	44
On nonlinear behavior of small-scale composite beams ( <i>Vaccaro, Marzia Sara; Barretta, Raffaele; Marotti de Sciarra, Francesco</i> ) . . . . .	44
Integral elasticity theories for composite structures ( <i>Vaccaro, Marzia Sara; Pinnola, Francesco Paolo; Barretta, Raffaele; Marotti de Sciarra, Francesco</i> ) . . . . .	45
Noise reduction response of additively manufactured structure ( <i>Dddaman, Snita; Kmar, Nan; Shrvast, Bhvna</i> ) . . . . .	46
Performance of a lightweight concrete-bamboo composite beam ( <i>Moy, Charles K.S.</i> )	46
On the use of Double – Double advanced material processing for the design of a composite fuselage barrel. ( <i>Di Caprio, Francesco; Tsai, Stephen W.; Riccio, Aniello; Russo, Angela</i> ) . . . . .	47
Flexural Behavior Evaluation of Repaired High Strength Geopolymer Concrete ( <i>Tashan, Jawdat</i> ) . . . . .	47
Impact characteristics of Quartz fiber/PEEK-MWNTs folded core sandwich radar-absorbing thermoplastic composites ( <i>Ji-Sub Noh; Byeong-Su Kwak; Jin-Hwe Kweon; Young-Woo Nam</i> ) . . . . .	47
Electromagnetic wave absorption characteristics of radar absorbing structure based on ceramic matrix composites in Ultra-high temperature ( <i>Shin, Joon-Hyung; Dong-Young Shim; Kweon, Jin-Hwe</i> ) . . . . .	48
Radar absorbing composite structures using periodic pattern surface with lightning strike protection and its application to leading edge ( <i>Shim, Dong-young; Shin, Joon-hyung; Kang, Young-hun; Kwoen, Jin-hwe; Nam, Young-woo</i> ) . . . . .	48
Development of microwave absorption heating and sound absorption folded core sandwich composite structure with Quartz/PEEK-MWCNTs ( <i>Jun-Hyeok Hwang; June-Woo Kwak; Jin-Hwe Kweon; Young-Woo Nam</i> ) . . . . .	49
Low-velocity impact response of aluminum alloy corrugated sandwich beams used for high-speed trains ( <i>Yu, Zhenhao; Liu, Kai; Zhou, Xiongfei; Jing, Lin</i> ) . . . . .	49

Fabrication, Characterization, and Evaluation of Electrospun Nanocomposite Fibrous Mats as Interlayer Reinforcements for Fiber Composites ( <i>Loizou, K.; Savva, I.; Georgallas, M.; Evangelou, A.; Drakonakis, V.</i> ) . . . . .	50
Enhancing the mechanical properties of carbon fiber reinforced composites by the incorporation of electrospun nanofibers at the interlayer ( <i>Georgallas, M.; Savva, I.; Loizou, K.; Evangelou, A.; Drakonakis, V.</i> ) . . . . .	51
<b>Composite structures in civil engineering</b> . . . . .	52
Numerical study of DTU 10MW reference Wind Turbine under Earthquake ( <i>Huang, Sam</i> ) . . . . .	52
Shaking table test study on seismic performance of UHPC rectangular hollow bridge pier ( <i>Ye Mengya; Guo Zhan; Chen Canwen; Chen Yu</i> ) . . . . .	52
Intelligent recognition for crack and leakage defects of tunnel structures based on deep learning ( <i>Hao Yang; Xiangyang Xu</i> ) . . . . .	52
Hysteretic behavior of recycled aggregate concrete with ferronickel slag-filled steel tubular columns ( <i>Luo Caisong; Wang Fengxuan; Guo Zhan; Qi Ai; Chen Yu</i> ) . . . . .	53
Compressive Behavior and a New Design-Oriented Stress-Strain Model for FRP-Confined Ultra-High Performance Concrete (UHPC) in Circular Columns ( <i>Jun-Jie ZENG; Jinjing Liao</i> ) . . . . .	53
Research on Early-age Behaviors of Timber-Concrete Composite Connector ( <i>XIN, Zhanwen; SORELLI, Luca; EMAMI, Hossein; LECOURS, Simon; NGUYEN, Truong Thanh</i> ) . . . . .	54
Experimental verification of a well-defined inflatable structures numerical simulation model ( <i>Abdelmaseeh, Amir; Elsabbagh Adel; Elbanhawwy Amr</i> ) . . . . .	54
Experimental investigation of the flexural response of CFST members Incorporated with DCLs ( <i>Khalaf, Salem; Abed, Farid</i> ) . . . . .	55
Effect of anchorage condition on prestressed NSM FRP system ( <i>Cho, Sanghyeon; Chung, Wonseok; Lee, Heeyoung</i> ) . . . . .	55
Flexural performance of steel fiber-reinforced concrete-filled stainless steel tubular trusses ( <i>Kong, Wenyuan; Zhou, Wenbo; Zhu, Yao; Zhang, Xiaoyong; Chen, Yu</i> ) . . . . .	55
Dynamic behavior and vulnerability assessment of base isolated structures ( <i>De Angelis, Fabio; Cancellara, Donato</i> ) . . . . .	56

Numerical analysis, optimization, and multi-criteria design of VIG composite panels ( <i>Kowalczyk, Izabela; Kozanecki, Damian; Krasoń, Sylwia; Rabenda, Martyna; Domagalski, Łukasz; Wirowski, Artur</i> ) . . . . .	57
The artificial intelligence methods in non-destructive testing of dynamic properties of VIG-type composite panels ( <i>Kozanecki, Damian; Kowalczyk, Izabela; Krasoń, Sylwia; Rabenda, Martyna; Domagalski, Łukasz; Lefk, Marek; Wirowski, Artur</i> ) . . . . .	57
Experimental study for the rehabilitation of pressure drinking water pipes using Glass Fiber Reinforced Polymer ( <i>Gras Travesset, Ferran; Pérez, Marco Antonio; Torras, Antoni Andreu</i> ) . . . . .	58
Assessment of the slip impact on the deflection of steel-concrete composite beams in the light of experimental tests ( <i>Kisala Dawid; Ostrowski Krzysztof Adam; Furtak Kazimierz</i> ) . . . . .	59
Push-out tests of welded bolt shear connectors ( <i>Perez, Marines; Bermudez, Carlos A.; Perea, Tiziano</i> ) . . . . .	59
<b>Composites in Innovative Applications (chaired by L Solazzi)</b> . . . . .	61
Torsional properties of GFRP-timber hybrid beams ( <i>DARWICH Hassan; GRAZIDE Cécile; JURKIEWIEZ Bruno</i> ) . . . . .	61
Characterization of shape memory wire-polymer composites from additive manufacturing ( <i>Eyer, Philipp; Trauth, Anna; Weidenmann, Kay André</i> ) . . . . .	61
STUDY ON THE INFLUENCE OF COLLABORATIVE SHELL COMPOSITE STRUCTURES ON THE CRASHWORTHINESS OF AN ELECTRIC MICROCAR ( <i>Acanfora, Valerio; Riccio, Aniello</i> ) . . . . .	61
Multifunctional heating film of silver nanoparticles as susceptor for induction welding of thermoplastic composite joints ( <i>Dae-Sung Lee; Jae-Hyung Jung; Hyeon-Seok Choe; Young-Woo Nam</i> ) . . . . .	62
Feasibility study of an innovative industrial vehicle transmission adopting aluminium and titanium alloy and composite materials instead of classical structural steel. ( <i>Solazzi, Luigi; Bertoli, Davide; Ghidini, Lorenzo</i> ) . . . . .	62
Implementation of electrode integration for carbon composite bipolar plate for VRFB ( <i>Kaur, Amanpreet; Lim, Jun Woo</i> ) . . . . .	63

Development of graphene oxide carbon felt composite electrode for vanadium redox flow battery ( <i>Kaur, Amanpreet; Lim, Jun Woo</i> ) . . . . .	64
Innovative RC permanent form and support system to minimize concrete casting works ( <i>Lee, Jeongun; Park, Ji Woon; Lim, Yun Mook</i> ) . . . . .	64
<b>Computational Mechanics in Manufacturing of Composite Structure</b> . . . . .	65
Numerical Modelling of Mould Compensation for Symmetrical Flat Laminate Composite Manufactured through Autoclave Process ( <i>LERDWONGPAISAN Arnon; CASTANIE Bruno; OLIVIER Philippe</i> ) . . . . .	65
Numerical investigation of the springback behaviour and residual stresses of a hybrid profile produced by the roll forming process ( <i>Ryll, Tobias; Kuhtz, Moritz; Nguyen, Minh; Filippatos, Angelos; Gude, Maik</i> ) . . . . .	65
<b>Data science for composite materials and structures (chaired by N Fantuzzi, H Hu, J Yang, W Huang, L Dong, Z Wu, M Montemurro, F Chinesta, L Chamoin, E Cueto</b> . . . . .	67
Data-Model-Driven Hybrid Computational Framework for Bi-stability Analysis ( <i>Kuang, Zengtao; Huang, Qun; Li, Ping; Yang, Jie; Hu, Heng</i> ) . . . . .	67
Structural-Genome-Driven method for composite plates ( <i>Yan Wei; Huang Wei; Huang Qun; Yang Jie; Hu Heng</i> ) . . . . .	67
Using Machine Learning in Composite Design: the Case of a Torsion Spring for Light Vehicles ( <i>Fragassa, Cristiano; Pavlovic, Ana; Lukovic, Marko; Minak, Giangiacomo</i> ) . . . . .	68
Prediction of temperature-dependent polyphenylsulfone tensile properties through a machine learning approach ( <i>Fragassa, Cristiano; Wentz, André Viegas; Lukovic, Marko; Cabreira, Vinicius; de Camargo, Vannucchi Felipe</i> ) . . . . .	69
<b>Delamination, damage and fracture</b> . . . . .	71
Influence of crack location and crack number on the responses of 3D representative unit cell of unidirectional composites ( <i>Huang, Sam</i> ) . . . . .	71
How to obtain similar responses from CFRP laminates subjected to low-velocity impact fatigue and fatigue indentation loading ( <i>Huo, Lubin; Alderliesten, René</i> ) . . . . .	71
Uncoupled cohesive laws including large scale bridging ( <i>Joki, Reidar Kvale; Grytten, Frode; Jørgensen, Jens Kjær; Sørensen, Bent F.</i> ) . . . . .	72

On the influence of non-woven carbon veils with different binders on mode-I interlaminar fracture toughness of carbon fibre/epoxy composite laminates ( <i>Wang, Sheng; Katnam, Kali Babu; Zou, Zhenmin; Potluri, Prasad</i> ) . . . . .	73
Influence of the restitution coefficient value on damage of composite shields protecting the chassis of a rail vehicle. ( <i>Juzuń Mateusz; Pawlak Mariusz</i> ) . . . . .	73
Spallation of thermal barrier coatings for gas turbine applications ( <i>Hay, Harry; Wang, Simon; Harvey, Christopher</i> ) . . . . .	74
Advanced finite element analysis of composite plates with two delamination fronts ( <i>Hauck, Bence; Szekrényes, András</i> ) . . . . .	75
Damage Detection and localization in FRP plates by lamb wave considering material anisotropy ( <i>Xu, Ying</i> ) . . . . .	75
Interactive characteristics of delamination damage growth of composite laminates under various sequential static and cyclic loading ( <i>Li, Shuxin; Duan, Qingfeng; Hu, Haixiao; Cao, Dongfong</i> ) . . . . .	76
Application of The Effective Crack Length Method to Model Delamination of Unidirectional Composite Laminates Under Mode II Shear Loadings ( <i>Liu, Heng (Hannah); Qi, Gang; Li, Chun (Lucy)</i> ) . . . . .	76
Impact damage of CFRP with preload ( <i>Barca Iga; Rośkowicz Marek; Komorek Andrzej; Przybyłek Paweł</i> ) . . . . .	77
Influence of distributed out-of-plane waviness defects on the mechanical behavior of CFRP laminates. ( <i>Calvo Orozco, José Vicente; Feito Sánchez, Norberto; Miguélez Garrido, María Henar; Giner Maravilla, Eugenio</i> ) . . . . .	77
A multi-scale damage model based on SCA method for unidirectional CFRP laminate ( <i>Cong Guo; Shengda Jiang; Ji He</i> ) . . . . .	77
Effects of the various aluminum surface modifications on the interfacial metal-composite adhesion of fiber metal laminates ( <i>Drozdziel-Jurkiewicz, Magda; Jakubczak, Patryk; Bienias, Jaroslaw</i> ) . . . . .	78
In-situ SEM investigation on the damage behavior of an interpenetrating metal ceramic composite ( <i>Schukraft, Joél; Morbitzer, Philipp; Siegmund, Frederik; Lohr, Christoph; Weidenmann, Kay A.</i> ) . . . . .	79
<a href="#">Design and application of composite structures</a> . . . . .	80



Aero-structural design, fabrication, and analysis of composite wind turbine blades for grid interactive hybrid renewable energy system ( <i>D, Muniraj; VM, Sreehari; AP, Haran; S, Govindaraj</i> ) . . . . .	80
DESIGN AND CHARACTERIZATION OF GRAPHENE RUBBER COMPOS- ITES TO ACHIEVE ZERO THERMAL EXPANSION ( <i>Yan, Han; Yao, Xuefeng</i> )	80
Design, analysis, manufacture and testing of the spacecraft mirror antenna with the composite high precision and size-stable solid surface reflector ( <i>Morozov, Evgeny; Lopatin, Alexander; Taygin, Vitaly</i> ) . . . . .	81
Design and form-finding of composite freeform structures ( <i>Moskaleva, Anastasiia; Sergey Gusev; Safonov, Alexander; Enrique Hernandez-Montes</i> ) . . . . .	82
FE simulation of distortion of CFRP part formed by the stamping process ( <i>Ryu, Jaechang; Shin, Dohoon; Lee, Chanjoo; Kim, Mingi; Ko, Daecheol</i> ) . . . . .	82
Systematic approach for designing composite blades of a tidal turbine based on both its theoretical beam model and FE shell model ( <i>Lee, JaeYong; Lee, Hakgu</i> )	83
Wear Performance of Thermoplastic Polymers Reinforced with Glass Fibres at Variable Fibre Volume Fractions ( <i>Zaghloul, Moustafa Mahmoud Yousry; Steel, Karen; Veidt, Martin; Heitzmann, Michael T.</i> ) . . . . .	84
Energy absorption characteristics of composite channel section structure under quasi-static compression loading ( <i>Lv Rui; Ren Yiru</i> ) . . . . .	84
Proposal and Effectiveness of Compression-free Braces Using Partially Fibered CFRP ( <i>Hamasaki Mizuki; Tsogbayar Tsendjav; Yamamoto Rino; Matsumoto Yukihiro; Taguchi Takashi; Shimizu Keisuke; Komiya Iwao; Nakajima koji</i> ) . . . . .	85
Compressive properties of polyurethane foam-filled Al/CFRP sandwich struc- tures: quasi-static and dynamic experiments ( <i>Yang, Chengxing; Chen, Zhifang; Yao, Shuguang</i> ) . . . . .	85
Design and Manufacturing of Composite 3D-printed Architected Material for Low Frequency Broadband Vibration Control ( <i>Muhammad; Kennedy, John</i> ) . . . . .	86
Design approach for automated transverse leaf spring composite structures in a suspension system ( <i>Gruenheid, Thomas; Deisser, Oliver; Sturm, Ralf</i> ) . . . . .	86
Sustainable optimal design of FRP composite structures ( <i>António, Carlos Conceição</i> )	87

EXPERIMENTAL STUDIES ON THE MECHANICAL PROPERTIES OF UNI- DIRECTIONAL GLASS/CARBON/EPOXY COMPOSITES ( <i>Agrawal, Mayank;</i> <i>Raghavalu Thirumalai, Durai Pranhakaran; Mahajan, Puneet</i> ) . . . . .	88
Durability and Ageing of Composite Materials and Structures (chaired by M. Gigliotti, F. Ascione) . . . . .	89
Durability of glass fiber and glass fiber-reinforced polymer (GFRP) bars in sim- ulated seawater ( <i>Lu, Zhongyu; Xie, Jianhe; Li, shixin; Tan, Yongqiang</i> ) . . . . .	89
Durability of BFRP bar in seawater environment: Coupling effects of SSGC wrap- ping and prestressing ( <i>Xie, Jianhe; Tan, Yongqiang; Lu, Zhongyu; Li, Shixing; Li,</i> <i>Jianglin; Huang, Liang</i> ) . . . . .	89
Hygrothermal durability of full scale beam-to-column adhesive joints: experimen- tal results and modelling ( <i>Ascione, Francesco; Granata, Luigi</i> ) . . . . .	90
Biodegradable Polymeric Composites Based on Pistachio Shell Powder – Synthe- sis and Characterization ( <i>Paczkowski, Przemysław; Gawdzik, Barbara</i> ) . . . . .	91
On the effect of environmental actions on the bond capacity of FRP concrete joints ( <i>Calabrese Angelo; Colombi Pierluigi; D’Antino Tommaso</i> ) . . . . .	91
A novel test for characterising the effects of thermo-oxidation ageing on damage onset in bonded joints for aeronautical applications ( <i>Masson, Julie; Gigliotti,</i> <i>Marco; Grandidier, Jean-Claude; Delozanne, Justine; Dagorn, Noelig</i> ) . . . . .	92
Experimental investigation on the hygroscopic ageing of carbon fiber reinforced vinylester resin composites ( <i>Zhang Yuheng; Ding Anxin</i> ) . . . . .	93
An Experimental Validated Model of Environmental Aging Accelerated Damage under Tension-tension Fatigue in Composites ( <i>Li, Zhiye; Michael Lepech</i> ) . . . . .	93
Effect of Thermal Cycling on Damage Onset in Three-Dimensional (3D) Woven Organic Matrix Composites for Aero-Engines Applications by in-situ X-Ray $\mu$ -Computed Tomography ( <i>Gigliotti, Marco; Orenes Balaciart, Salvador; Pannier,</i> <i>Yannick; Mellier, David; Guigon, Camille</i> ) . . . . .	94
Hygrothermal ageing and progressive damage modelling of CFRP laminates under quasi-static tensile loading ( <i>XU, Jian; Hu, Mengting; SUN, Liangliang; HAN, Xiao</i> )	94

Thermo-mechanical Viscoelastic Behaviors with Consideration to Physical Aging for CF/EP Laminates: Experiments and Constitutive Modeling ( <i>Yang jiangyan; Ma xiaofei; Wang hui; Shang fulin; Hou demen</i> ) . . . . .	95
Hygrothermal behaviour of adhesive bonded connections ( <i>Maurel-Pantel, Aurelien; Lamberti, Marco; Lebon, Frederic</i> ) . . . . .	95
<b>Dynamics of Composite Materials</b> . . . . .	96
An investigation of deformation and failure mechanisms of fiber-reinforced composites in layered composite armor ( <i>Guo</i> ) . . . . .	96
Dynamic Instability of Rotating Tapered Composite Shaft Subjected to Time-varying Axial Loading ( <i>Najafi, Mohsen; Ganesan, Rajamohan</i> ) . . . . .	96
High strain rate dynamic tensile behavior of chopped glass fiber polypropylene composite at high and low temperatures ( <i>Se-Min Lee; Dug-Joong Kim; In-Soo Han; Hak-Sung Kim</i> ) . . . . .	97
An analysis of modified CT specimens for the determination of the longitudinal intralaminar fracture toughness in composite laminates using SHPB configuration ( <i>Cimadevilla Díez, Adrián; Vaz-Romero, Álvaro; Pernas Sánchez, Jesus; ARTERO GUERRERO, Jose Alfonso; Maimi, Pere; GONZALEZ JUAN,EMILIO VICENTE</i> ) . . . . .	98
Multimode dynamic response analysis of curved composite panels under dynamic in-plane loading using a Finite Element based Reduced Order Model ( <i>Jansen, Eelco; Rahman, Tanvir</i> ) . . . . .	98
The Influence of Conditioning on Dynamic Properties of Polymer Composites ( <i>Borowiec, Marek; Kosicka, Ewelina; Krzyzak, Aneta</i> ) . . . . .	99
<b>Experimental Methods</b> . . . . .	100
Characterization of out-of-plane tensile stress-strain behavior for GFRP composite materials at elevated temperatures ( <i>Ziqing Hao; Chen, Guangchang; Ke, Hongjun; Deng, Linlin; Liu, Liu</i> ) . . . . .	100
Effect of Seasoning Conditions on the Mechanical Properties of Modified Adhesive Compositions Based on Bisphenol A Epoxy Resin ( <i>Miturska-Barańska, Izabela</i> )	100
Numerical and experimental damage process of real L-shaped thin-walled columns under axial shortening ( <i>Gawryluk, Jaroslaw; Teter, Andrzej</i> ) . . . . .	101

A novel approach for determining the intra-ply energy release rate of composites made of prepreg ( <i>Rose, Philip; Linke, Markus; Busquets, David</i> ) . . . . .	102
Fatigue characterization of glass fibre/acrylic based infusible thermoplastic composite intended for offshore structural applications: Thermography and Acoustic Emission. ( <i>Hejjaji, Akshay; Portela, Alexandre; Comer, Anthony</i> ) . . . . .	102
Experimental studies of the thermal contact conductance for bundles of round steel bars ( <i>Wyczółkowski, Rafał; Bagdasaryan, Vazgen; Tomczyk, Barbara</i> ) . . . . .	103
Thermoplastic and Bio-based epoxy infusible resin systems: candidates for offshore renewable energy structural applications ( <i>Portela, Alexandre; Hejjaji, Akshay; Bhatia, Gursahib Singh; Comer, Anthony</i> ) . . . . .	104
Automated Manufacturing and mechanical properties of bio-inspired carbon fiber laminates ( <i>Rodríguez-García, Verónica; Aguado, Leticia; S.Maamri, V. Martinez; Lorenzo, Miguel; Guzman de Villoria, Roberto</i> ) . . . . .	104
Research solution for automatic analysis of drilling fiber-reinforced materials ( <i>Hrechuk, Andrii; Hörndahl, Mikael; Schultheiss, Fredrik</i> ) . . . . .	105
<b>Failure of Composites</b> . . . . .	106
Multiscale modeling based failure criterion of injection molded SFRP composites considering skin-core-skin layered microstructure and variable parameters ( <i>Li, Zeyang</i> ) . . . . .	106
Discrete Element approach to simulate debonding process in 3D short glass fibre composite materials under hygrothermal conditions ( <i>Ammar Ahmed; Leclerc Willy; Haddad Hamza; Guessasma Mohamed; Haddar Nader</i> ) . . . . .	106
Modelling progressive damage development under fatigue of a laminate with a hole ( <i>Maneval, Victor; Vedvik, Nils Petter; Echtermeyer, Andreas T.</i> ) . . . . .	107
Experimental Study of Off-Axis composite laminates subjected to dynamic compression: The Open Hole effect ( <i>Rodríguez Sereno, José Manuel; Pernas-Sánchez, Jesús; Artero Guerrero, José Alfonso; López-Puente, Jorge</i> ) . . . . .	107
Tensile behaviour of two systems of Carbon Reinforced Cementitious Matrix (CFRCM) ( <i>Rodríguez-Marcos, María; Villanueva-Llaurado, Paula; Fernández-Gómez, Jaime; López-Rebollo, Jorge</i> ) . . . . .	108

In-situ investigation of the damage behaviour of an interpenetrating metal matrix composite based on metallic glass (Ni60Nb20Ta20) ( <i>Dittmann, Kerstin; Trauth, Anna; Weidenmann, Kay</i> ) . . . . .	109
Predicting the effects of material system parameters and stacking sequence on the failure mechanisms of composite laminates ( <i>Minh Hoang, Nguyen; Anthony M., Waas</i> ) . . . . .	110
Tensile and shear response of epoxy and carbon/epoxy materials at different loading rates ( <i>Choi, Tae-Seong; Kim, Hye-gyu; Ji, Wooseok</i> ) . . . . .	110
Implementation of advanced approaches based on Continuum Damage Mechanics for composite failure analysis: status and way forward ( <i>Herman, Melanie; Leon-Dufour, Jean-Luc; Peters, Philippe; Laurin, Frédéric; Turon, Albert; Arteiro, Albertino</i> ) . . . . .	111
<b>FRP in concrete, steel and composite steel/concrete structures</b> . . . . .	112
Delamination buckling of FRP strips in the strengthening of beam elements ( <i>Capozucca, Roberto; Magagnini, Erica; Bettucci, Elisa</i> ) . . . . .	112
SHORT AND LONG TERM DEFLECTION ANALYSIS OF FRP STRENGTHENED RC MEMBERS ( <i>Slaitas Justas; Valivonis Juozas</i> ) . . . . .	112
EFFECT OF SPECIMEN SIZE ON COMPRESSIVE BEHAVIOR OF FRP-CONFINED RECTANGULAR CONCRETE COLUMNS ( <i>Pronnoy Bhat; Rimen Jamatia</i> ) . . . . .	112
<b>FRP reinforced concrete structures</b> . . . . .	114
Design-Oriented Stress-Strain Model for FRP-Confined Ultra-High Performance Concrete (UHPC) ( <i>Jun-Jie ZENG; Jinjing Liao</i> ) . . . . .	114
One-way High Strength plain and FRC Slabs Reinforced with Basalt FRP Bars: A Study on the Experimental and Analytical Shear Behavior ( <i>Al-Hamrani, Abathar; Alnahhal, Wael</i> ) . . . . .	114
Shear Capacity Prediction of FRP-RC Beams Using Single and Ensemble explainable Machine Learning Models ( <i>Wakjira, Tadesse; Al-Hamrani, Abathar; Ebead, Usama; Alnahhal, Wael</i> ) . . . . .	114
Study on shear resistance of GFRP reinforced seawater sea-sand concrete beams without stirrups ( <i>Yao Zhu; Yuhang Fang; Yu Chen; Xiaoyong Zhang; Wenyuan Kong</i> ) . . . . .	115

Structural Behavior of Negative Moment Region NSM CFRP Strengthened T-Beams with Various Embedment Depth under Monotonic and Cyclic Loading ( <i>Haryanto, Yanuar; Hu, Hsuan-Teh; Hsiao, Fu-Pei; Han, Ay Lie; Wiranata, Chua Andre; Salim, Fernando; Nugroho, Laurencius</i> ) . . . . .	116
Fire behaviour of concrete structures reinforced with GFRP bars: Experimental tests, numerical simulations and design ( <i>Rosa, Inês C.; Duarte, António P. C.; Arruda, Mário R. T.; Firmo, João P.; Correia, João R.</i> ) . . . . .	116
Energy Equivalence Dependent Mathematical Model for Homogenization of Carbon Fiber-Reinforced Concrete Panels under Impulsive Load ( <i>Singamsetty, Sreenitya; Matsagar, Vasant</i> ) . . . . .	117
Redistribution of moments in two-span externally post-tensioned beams with FRP rebars ( <i>Lou, Tiejiong; Li, Zhangxiang; Pang, Miao</i> ) . . . . .	118
Study on the flexural and debonding performance of Externally Bonded Reinforcement on Groove (EBROG) FRP strengthened RC beams ( <i>Codina, Alba; Barris, Cristina; Aghabagloo, Mehdi; Baena, Marta; Torres, Lluís</i> ) . . . . .	118
<b>Functionally graded materials and structures</b> . . . . .	120
Transient Response of Collinear Griffith Cracks in a Functionally Graded Strip Bonded between Dissimilar Elastic Strips under Shear Impact Loading ( <i>Singh, Ritika</i> ) . . . . .	120
Static and dynamic analysis of re-entry vehicle nose structures made of different functionally graded materials ( <i>Balaraman, P; Sreehari, VM</i> ) . . . . .	120
Buckling of Sigmoid Functionally Graded Sandwich Plates ( <i>Hadji, Lazreg; Avcar, Mehmet; Civalek, Omer; Akgoz, Bekir</i> ) . . . . .	120
Functionally graded "Ti – Ta(O,N)" structure and its production using high-temperature induction PVD ( <i>Fomin, Aleksandr; Fomina, Marina; Koshuro, Vladimir</i> )	121
Limit states of infinitely wide and stiffened plates made of FGM under compression in the elastic range ( <i>Teter Andrzej; Kolakowski Zbigniew</i> ) . . . . .	121
Thermoelectroelastic deformation of a FGM-coated half-space ( <i>Vasiliev Andrey; Volkov Sergei; Aizikovich Sergei</i> ) . . . . .	122
Application of DSQ element for static bending, free vibration and buckling analysis of FGM plate ( <i>Maknun, Imam Jauhari; Natarajan, Sundararajan; Katili, Irwan</i> )	122

Nonlinear bending of functionally graded metamaterial composite beams ( <i>Zhao, Shaoyu; Zhang, Yingyan; Zhang, Yihe; Yang, Jie; Kitipornchai, Sritawat</i> ) . . . . .	123
Thermal Buckling in a functionally graded Magneto-Electro-Elastic microbeam model including microstructure effect ( <i>Zhang, Gongye; Hao, Yingjie; Mi, Changwen</i> )	123
Geometrically nonlinear study of functionally graded saturated porous plates under thermal environment based on refined shear deformation plate theory and Biot's theory ( <i>Naveen Kumar H S; Subhaschandra Kattimani; Flavio D Marques</i> )	124
Wave propagation in Axially Functionally Graded Timoshenko-Ehrenfest Nanobeams ( <i>Arda, Mustafa; Majak, Jüri; Mehrparvar, Marmar</i> ) . . . . .	124
Linear and Nonlinear Analysis of Composite and Hybrid Axisymmetric Shells ( <i>Moita, José S.; Araújo, Aurélio .L.; Correia, Victor F.; Mota Soares , Cristóvão M.</i> ) . .	124
Influence of skewness on the dynamic response of graphene reinforced FG-porous sandwich plates resting on elastic foundation considering blast impact ( <i>Shakir, Mohammed; Talha, Mohammad</i> ) . . . . .	125
Influence of material uncertainty on free vibration characteristics of cracked functionally graded plates with microstructural defects ( <i>Raza, Ahmed; Pathak, Himanshu; Talha, Mohammad</i> ) . . . . .	125
<b>Health Monitoring Techniques in Composite Structures</b> . . . . .	127
Computer vision-based deformation analysis of tunnel structure ( <i>Xu Xiangyang; Hao Yang</i> ) . . . . .	127
In-situ detection of aging effects in hybrid specimens using resonant inspection techniques - Part III: Separation, identification and quantification of superposing changes in multi-material structures ( <i>Gundlach, Christian; Karch, Jens; Hopmann, Chris; Dilger, Klaus; Hartwig, Sven</i> ) . . . . .	127
<b>Impact Problems</b> . . . . .	129
Numerical evaluation of compression after impact in second generation of fibre metal laminates ( <i>Podolak, Piotr; Jakubczak, Patryk</i> ) . . . . .	129
The numerical analysis of titanium-carbon laminates impact behaviour using ductile damage model and Johnson-Cook damage model ( <i>Droździel-Jurkiewicz, Magda; Podolak, Piotr; Jakubczak, Patryk</i> ) . . . . .	129

An experimental and numerical study on the local and structural influence of the skin fiber pattern on the behavior of sandwich composite plates with foam core under low-velocity impact loadings ( <i>Merle, Maxime; Gigliotti, Marco; Grandidier, Jean Claude; Dupré, Jean Christophe; Egea, William</i> ) . . . . .	130
A global-local approach to the high-fidelity impact analysis of composite structures based on node-dependent kinematics ( <i>Nagaraj, Manish H.; Carrera, Erasmo; Petrolo, Marco</i> ) . . . . .	131
Impact Damage Modelling in Composite Structures Including Strain Rate Effects ( <i>Ivančević, Darko; Stanić, Luka</i> ) . . . . .	132
Experimental and numerical investigation of the low velocity impact behavior of stochastic tow based discontinuous composite beams ( <i>Ryatt, Jeremy; Ramulu, Mamidala; Pahuja, Rishi</i> ) . . . . .	132
Damage assessment of sandwich structures with CNT reinforced carbon-epoxy composite face sheets under impact load at elevated temperatures ( <i>D, Muniraj; VM, Sreehari</i> ) . . . . .	133
Low velocity impact response of inter-ply S2-glass and aramid woven composites: A numerical study ( <i>Rezasefat, M; Silva, AAX da; Amico, C; Giglio, M; Manes, A</i> ) .	133
MODELING AND SCALING LAWS FOR LOW VELOCITY IMPACTS OF COMPOSITE PLATES ( <i>Di Mauro, Genmaro; Russo, Pietro; Guida, Michele</i> ) . . .	134
Investigating the effect of impactor shape and hardness on the low velocity impact performance of carbon fibre reinforced polymer panels for aerostructures ( <i>Hall, Zoe; Liu, Jun; Brooks, Richard; Ding, Yuzhe; Liu, Haibao; Kinloch, Anthony; Dear, John</i> ) . . . . .	134
<b>Joints</b> . . . . .	136
The mode-II and mix mode-I/II fracture behaviour of hybrid joints obtained by co-curing epoxy composite on to PEEK and PPS composites ( <i>QUAN DONG; Zhao Guoqun; Rene ´ Alderliesten</i> ) . . . . .	136
Effect of nanostructures fabricated on aluminum alloy on mode [Please insert into preamble] fracture toughness in dissimilar joints of carbon fiber reinforced thermoplastics and aluminum alloy ( <i>Shima Momoka; Harada Kazuki; Saito Kei; Hosoi Atsushi; Kawada Hiroyuki</i> ) . . . . .	136



Processes and device arrangements for making shape memory fiber reinforced debondable adhesives ( <i>Moktadir, Monem; Hwang, Hui Yun</i> ) . . . . .	137
Enhancing the quasi-static strength of co-cured bonded laminate joints via multiscale toughening ( <i>Inal, Oguzcan; Potluri, Prasad; Soutis, Constantinos; Katnam, Kali-Babu</i> ) . . . . .	138
Particle-based micromechanical modelling of adhesive joint considering microscale surface roughness ( <i>Wang, Xinger; Hou, Xiaonan; Ye, Jianqiao; Pang, Kai; Yang, Jian</i> )	139
Modal analysis of adhesive joints using a radial point interpolation method ( <i>Ramalho, LDC; Sánchez-Arce, IJ; Gonçalves, DC; Campilho, RDSG; Belinha, J</i> ) . . . . .	139
Influence of Low and High Temperature on Hygrothermal Aged Aluminum-CFRP (plain woven) Hybrid Joints under Tensile–Shear Loading ( <i>Hanyu Zhang; Zhouzhou Song; Lei Zhang; Zhao Liu; Ping Zhu</i> ) . . . . .	140
Influence of aging effects on the bond strength of aluminum die castings and thermoplastics ( <i>Julian, Steinberg; Sven, Hartwig</i> ) . . . . .	140
Water contact angle measurements revisited - statistical analysis of the potential to distinguish CFRP surface treatments reliably ( <i>Koskinen, VV; Lahtonen, K; Jokinen, J; George, L; Hakala, P; Kanerva, M</i> ) . . . . .	141
CONNECTIONS IN MIXED STRUCTURES WITH H-SHAPED STEEL COLUMNS WITH PRE-INSTALLED THREADED RODS AND NORMAL STRENGTH CONCRETE BEAMS FOR ZONES OF HIGH SEISMIC ACTIVITY ( <i>Gutierrez, Oscar; Bermúdez, Carlos</i> ) . . . . .	142
<a href="#">Keynote Lectures</a> . . . . .	143
Energy absorbing lightweight materials ( <i>Cantwell, Wesley; Alia, Ruzanna; Zhou, Jin; Umer, Rehan</i> ) . . . . .	143
NONLINEAR MECHANICS OF SANDWICH PLATES ( <i>Amabili, Marco; Reddy, J.N.</i> )	143
FINITE ELEMENT UNIFIED FORMULATION COMBINED WITH PROGRESSIVE DAMAGE ANALYSIS: A NEW APPROACH TO PREDICT FAILURE MECHANISMS IN COMPOSITE LAMINATES ( <i>Tita, Volnei; Ferreira, Antonio</i> ) . . . . .	143
Varicomposites: spatially and temporally variable properties for sustainable performance ( <i>Weaver, Paul</i> ) . . . . .	144

Recent advances in the optimisation of variable stiffness composite structures: challenges and prospects ( <i>Montemurro, Marco</i> ) . . . . .	144
Nonlinear vibration of composite beams, plates and shells subjected to compression and shear loadings by unified finite elements and comparison with VCT experiments ( <i>Carrera Erasmo; Pagani Alfonso; Augello Riccardo; Azzara Rodolfo</i> ) . .	145
Buckling of sandwich panels with piezoelectric sensors and actuators ( <i>Afonso, Alexandre; Tomé, Marta; Araujo, Aurelio</i> ) . . . . .	145
High-performance carbon felt electrodes of vanadium redox flow batteries ( <i>Kwang Il Jeong; Jae-Moon Jeong; Seong Su Kim</i> ) . . . . .	146
Modelling the mechanical behaviour of natural fibre reinforced composites ( <i>Santiuste, Carlos; Jiao-Wang, Liu; Díaz-Álvarez, Antonio</i> ) . . . . .	146
The effects of interlayer toughening on progressive damage and failure of composite laminates ( <i>Waas, Anthony M.</i> ) . . . . .	147
Theoretical and numerical models for shells ( <i>Polit, Olivier</i> ) . . . . .	147
FE model for global buckling analysis of composite beams ( <i>Lanc, Domagoj; Turkalj, Goran; Banic, Damjan; Kvaternik Simonetti, Sandra</i> ) . . . . .	147
Non Classical/Non-Local Descriptions in Microstructured Composite Materials via Discrete-Continuous Models ( <i>Trovalusci, Patrizia</i> ) . . . . .	148
Metamaterials and Bio-Composites for Sustainable Aviation and Transport ( <i>Scarpa, Fabrizio</i> ) . . . . .	149
Micromechanical Modelling of Composites Based on Asymptotic Homogenization Method ( <i>Kalamkarov, Alexander L.</i> ) . . . . .	149
Wood as a sustainable material for transportation industry ( <i>Bruno Castanié</i> ) . . . .	150
Advances in Peridynamics ( <i>Madenci, Erdogan</i> ) . . . . .	150
High-precision computation in mechanics of composite structures through a strong sampling surfaces formulation ( <i>Kulikov Gennady</i> ) . . . . .	151
Data-driven multiscale analysis for composite structures ( <i>Heng Hu</i> ) . . . . .	151
Relative entropy in homogenization of the fiber-reinforced composites ( <i>Kamiński, Marcin</i> ) . . . . .	151
Verification of the effect of flexible composite prostheses on bone healing by using a novel simulation method ( <i>Chang, Seung Hwan</i> ) . . . . .	152

Structural Design and High-accuracy Manufacturing Process of Filament Wound Composite Pressure Vessels ( <i>Zu, Lei; Zhang, Qian; Zhang, Guiming; Xia, Xianzhao; Liu, Honghao</i> ) . . . . .	152
Modelling of Quasi-static and Dynamic Damage Process of Interpenetrated Metal- Ceramic Composites ( <i>Tomasz Sadowski; Eligiusz Postek; Daniel Pietras; Jajnabalkya Guhathakurta; Marek Boniecki</i> ) . . . . .	153
<b>Micromechanics</b> . . . . .	154
Multiscale thermoelastic analyses of fibre-reinforced composites by high-order unified finite element models ( <i>Racionero Sanchez-Majano, Alberto; Masia, Rebecca; Pagani, Alfonso; Zappino, Enrico; Carrera, Erasmo</i> ) . . . . .	154
The Effect of Poisson's Ratio on the Static and Dynamic Behavior of Carbon Nanotubes Through Doublet Mechanics ( <i>Koc, Hilal; Tüfekci, Ekrem</i> ) . . . . .	154
Features of DLC + Si coating wear under microcontact conditions ( <i>Kuznetsova, Tatyana; Lapitskaya, Vasilina; Khabarava, Anastasiya; Trukhan, Ruslan; Chizhik, Sergei; Torskaja, Elena; Fyodorov, Sergei; Aizikovich, Sergei; Sadyrin, Evgeniy</i> ) . . . . .	156
A novel method of fourth-order orientation tensor approximation for stiffness prediction of short fibre composites ( <i>Ogierman, Witold</i> ) . . . . .	156
Thermally induced residual micro-stresses in hybrid composite laminates with tow-level fibre hybridization ( <i>Romano, Giuseppe; Nagaraja Rao, Yeshwanth; Zou, Zhenmin; Potluri, Prasad; Katnam, Kali Babu</i> ) . . . . .	156
A Numerical Investigation into the Poisson Effect under the Iso-strain and the Iso-stress Conditions ( <i>Luo, Yunhua</i> ) . . . . .	157
Micro-structural effects in phononic dielectric structures ( <i>Sladek, Vladimir; Sladek, Jan; Sator, Ladislav; Li, Yueqiu</i> ) . . . . .	157
<b>Modeling, simulation and testing of sandwich and adaptive structures</b> . . . . .	159
Damage modelling of woven carbon fiber and epoxy matrix composite sandwiches under impact loadings ( <i>LACHAUD Frédéric; RIGANTI Matteo; SIMARRO Pau; JEZEGOU Joel</i> ) . . . . .	159
Experimental and numerical study on the effect of interlaminar properties on the structural properties of steel/polymer/steel crashboxes ( <i>Harhash, Mohamed; Kultz, Moritz; Richter, Jonas; Hornig, Andreas; Gude, Maik; Palkowski, Heinz</i> ) . . . . .	160

<b>Morphing of composites</b> . . . . .	162
Development of a new flexible wing concept for unmanned aerial vehicle using corrugated core made by 4D printing of composites ( <i>Hoa, Suong; Abdali, Marjan; Jasmin, Anick; Radeschi, Daniel; Ladous, Victor; Faour, Hadi; Kobaissi, Backar</i> ) . . . . .	162
<b>Multi-scale Modeling of Graphene- and Carbon Nanotube-Reinforced Composites</b> . . . . .	163
THERMAL BUCKLING ANALYSIS OF LAMINATED CONICAL SHELLS CONTAINING CARBON NANOTUBE PATTERNED LAYERS WITHIN DIFFERENT SHEAR DEFORMATION THEORIES ( <i>Mahmure, Avey; Fantuzzi, Nicholas</i> ) . . . . .	163
<b>Nano-Composites</b> . . . . .	164
Establishing the polymer effect on the viscoelastic properties of CNTs reinforced PEI and PEEK ( <i>Kayginok, Fulden; Karabal, Merve; Yildiz, Alptekin; Yildiz, Kaan; Cebeci, Hulya</i> ) . . . . .	164
Void Detection of Nano-Grout using Heating and Magnetic Property ( <i>Heeyoung Lee; Sanggyu Park; Yangsub Shin; Wonseok Chung</i> ) . . . . .	165
Mechanical, physical, and thermal properties of the particle-blended epoxy adhesive for composite repair application ( <i>Lai, Wei Liang; Saeedipour, Hamid; Goh, Kheng Lim</i> ) . . . . .	165
Trial of a spinning method to control the cross-sectional shape and investigation of dimensional effects of carbon nanotube yarns ( <i>Tateiwa, Rina; Atsushi, Murata; Kawada, Hiroyuki; Hosoi, Atsushi</i> ) . . . . .	166
Effects of Heat Treatment and MWCNTs on Scratch Resistance of the Epoxy Resin doped with TiO <sub>2</sub> ( <i>Mucha, Mateusz; Duda, Jarosław; Zwarycz, Dominik; Szczepaniak, Robert; Krzyzak, Aneta; Kościński, Mikołaj; Sterzynski, Tomasz; Sałaciński, Michał</i> ) . . . . .	167
<b>Natural Fibre Composites</b> . . . . .	168
On the buckling behavior of nonlinear biodegradable composite columns ( <i>WANG, LIU JIAO; SANTIUSTE ROMERO, CARLOS</i> ) . . . . .	168
Assessment of innovative bio-composite materials by experimental tests ( <i>Magnini, Erica; Bettucci, Elisa; Khatir, Abdelwahhab; Khatir, Samir</i> ) . . . . .	168

Numbers don't lie: Does the new sustainability agenda require a switch to bio-composites in the design of marine composite structures? ( <i>Proud, William; Trask, Richard; Hamerton, Ian; Longana, Marco</i> ) . . . . .	169
Can the recycling problem of waste printed circuit boards be solved with plant-based fiber-reinforced composites? ( <i>Genc, Garip; Kesen, Ugur</i> ) . . . . .	169
Dissolution of a commercial regenerated cellulose fibre (Cordenka) in the ionic liquid 1-ethyl-3-methylimidazolium acetate studied using time-temperature superposition ( <i>Alanazi, Maer; Ries, Michael; Hine, Peter</i> ) . . . . .	170
<b>Non-destructive Inspection Techniques for Composite Materials and Structures</b> . . . . .	171
Modeling of nanoindentation experiments of thin ceramic coatings ( <i>Aizikovich, Sergei; Vasiliev, Andrey; Sadyrin, Evgeniy</i> ) . . . . .	171
Mathematical approach of the load estimation applied on the tooth fissure ( <i>Zelentsov Vladimir; Sadyrin Evgeniy; Swain Michael; Lapina Polina; Aizikovich Sergei</i> ) . . . . .	171
Non-destructive inspection of military designated composite materials with the use of infrared and Terahertz imaging ( <i>Strag, Martyna; Hlosta, Pawel; Świdorski, Waldemar</i> ) . . . . .	172
Non-destructive inspection of internal defects of the polymer tube using pulsed Terahertz waves based on generative adversarial networks ( <i>Kim, Sang-Il; Park, Dong-Woon; Kim, Heon-Su; Kim, Hak-Sung</i> ) . . . . .	172
Optimal shunted damping configurations for noise reduction in laminated composite sandwich panels - Multi-modal damping ( <i>Cotrim, Bruno Ribeiro; Araújo, Aurélio Lima; Madeira, José Firmino Aguiar</i> ) . . . . .	173
<b>Optimization techniques and methods</b> . . . . .	175
Reduction of free-edge effects around a hole of a composite plate using a numerical layup optimization ( <i>Kharghani, Navid; Mittelstedt, Christian</i> ) . . . . .	175
Design optimization of composite shaft subjected to torsional loading using Artificial Neural Network modeling based on Genetic Algorithm ( <i>Nair, Ajeesh Suresh; Ganesan, Rajamohan</i> ) . . . . .	175
<b>OPTIMIZATION OF GREEN COMPOSITE LAMINATES UNDER IMPACT</b> ( <i>Giammaria, Valentina; Del Bianco, Giulia; Raponi, Elena; Boria, Simonetta; Duddeck, Fabian</i> ) . . . . .	176

Multi-scale topology optimization of composite beams accounting for loading un-	
certainty ( <i>Bruggi, Matteo; Ismail, Hussein; Lógó, János</i> ) . . . . .	176
<b>Porous and cellular materials</b> . . . . .	178
Predicting Elastic Properties of Composite Metal Foams using 3D Finite Element	
Method ( <i>M. Keleshteri, Mohammad; Jelovica, Jasmin</i> ) . . . . .	178
Characterization of the foaming behavior of glass fiber reinforced polypropylene	
under varying manufacturing parameters ( <i>Alessandra, Kummerow; Sven, Hartwig</i> )	178
Development and characterization of in-situ sandwich panels with aluminum alloy	
foam core ( <i>Caldeira, Ana Sofia; Vesenjaj, Matej; Carneiro, Vitor H.; Krstulović-Opara,</i>	
<i>Lovre; Duarte, Isabel</i> ) . . . . .	179
Development and characterization of aluminum alloy foam – cork hybrid struc-	
tures ( <i>Sousa, João D. P.; Pinto, Susana C.; Vesenjaj, Matej; Krstulović-Opara, Lovre;</i>	
<i>Carneiro, Vitor H.; Marques, Paula A.P.; Duarte, Isabel</i> ) . . . . .	179
Mechanical properties of the aluminum foam-filled tubes ( <i>Duarte, Isabel; Vesenjaj,</i>	
<i>Matej; Krstulović-Opara, Lovre</i> ) . . . . .	180
<b>Probabilistic modeling and reliability of composites</b> . . . . .	181
Prediction of temperature regimes in pultrusion of thermoplastic laminates. ( <i>Minchenkov</i>	
<i>Kirill; Safonov Alexander; Gusev Sergei; Rubtcov Maxim; Akhatov Iskander</i> ) . . . . .	181
<b>Smart Composites</b> . . . . .	182
Flutter analysis of damaged composite plates under hygro-thermal environment	
and its passive control using piezoelectric patches ( <i>Kuriakose, Vinu M; Sreehari</i>	
<i>VM</i> ) . . . . .	182
Thermo-structural analysis of smart composite plates having internal flaw ( <i>Vinu</i>	
<i>M Kuriakose; Sreehari VM</i> ) . . . . .	182
Reversible energy absorbing behaviors of shape-memory thin-walled structures	
( <i>Jin Wang; Guangyu Sun; Kui Wang; Song Yao; Yong Peng</i> ) . . . . .	182
Effective magneto-elastic coupling in magnetostrictive Terfenol-D composites ( <i>Lin,</i>	
<i>Yin-Zhao; Lin, Chien-hong</i> ) . . . . .	183
Experimental verification of smart structures composed of PVDF ribbon grid	
sensor embedded carbon/epoxy fabric prepregs ( <i>Jia-le Che; In-Jun Jung; Seung-</i>	
<i>Hwan Chang</i> ) . . . . .	183

<b>Stability of Nano, Micro and Macro Composite Structures</b> . . . . .	184
Approximate local postbuckling analysis of composite panels braced with omega-stringers ( <i>Schilling, Jakob C.; Mittelstedt, Christian</i> ) . . . . .	184
Experimental and numerical approach for predicting global buckling load of pressurized unstiffened cylindrical shells using vibration correlation technique ( <i>Jeon, Min-Hyeok; Kong, Seung-Taek; Hyun-Jun Cho; In-Gul Kim; Chang-Hoon Sim; Jae-Sang Park; Joon-Tae Yoo; Yeoung-Ha Yoon</i> ) . . . . .	184
<b>Structural Health Monitoring</b> . . . . .	186
Quantitative damage monitoring of composite structures under cyclic loading using thermography and image processing ( <i>Chen, Xiao; Sheiati, Shohreh</i> ) . . . .	186
Damage Detection of Civil Structures using Artificial Neural Networks and Refined Component-Wise Finite Element Models ( <i>Enea, Marco; Shen, Jiahui; Paganini, Alfonso; Carrera, Erasmo</i> ) . . . . .	186
Piezoresistive Properties of MWCNT,CB,GNP/Epoxy Composites ( <i>Zehni, Ozan Can; Kinloch, Ian; Bissett, Mark</i> ) . . . . .	186
<b>Thermal problems on Composite structures</b> . . . . .	188
EXACT 3D COUPLED HYGRO-ELASTIC SHELL MODEL FOR MULTILAYERED STRUCTURES ( <i>Brischetto, Salvatore; Torre, Roberto; Cesare, Domenico</i> ) .	188
Microstructure of epoxy resin composite modified with recycled fine aggregate ( <i>Krzywiński, Kamil; Sadowski, Łukasz; Krakowiak, Konrad</i> ) . . . . .	188
Investigations of thermal-dynamic mechanical properties and the glass transition temperature of epoxy composites with silicon carbide (SiC) and tungsten carbide (WC) particles ( <i>Kucharczyk, Wojciech; Stawarz, Sylwester; Żurowski, Wojciech; Bakar, Mohamed; Opara, Tadeusz; Rucki, Mirosław; Gevorkyan, Edwin; Biłkowska, Anita</i> ) . . . . .	189
Ply-resolved quantification of thermal degradation on carbon fibre-reinforced polymers ( <i>Bibinger Johannes; Eibl Sebastian; Gudladt Hans-Joachim</i> ) . . . . .	190
A new combined asymptotic-tolerance model of thermoelasticity problems for thin biperiodic cylindrical shells ( <i>Tomczyk Barbara; Bagdasaryan Vazgen; Gołąbczak Marcin; Litawska Anna</i> ) . . . . .	190

Determination of heat deflection temperature under load (HDT) and Vicat softening temperature (VST) of powder composites used for ablative coatings ( <i>Szczepaniak Robert; Sapinski Przemyslaw; Plonka Daniel; Krzyzak Aneta; Kosicka Ewelina</i> ) . . . . .	191
Analysis of ablative properties of hybrid composite with fiber reinforcement and powder aerogel ( <i>Szczepaniak Robert; Wróblewski Mikołaj; Przybyłek Paweł; Krzyzak Aneta; Komorek Andrzej; Bąbel Robert</i> ) . . . . .	191
<b>Variable Stiffness Composite Laminates</b> . . . . .	193
Composite optimized design for fibre placement manufacturing and additive manufacturing ( <i>Van den Brink, Wouter; Maas, Robert</i> ) . . . . .	193
Improved buckling performance of fibre-steered laminated plates with embedded pseudo-stiffeners ( <i>McInnes, Calum J.; Pirrera, Alberto; Kim, Byung Chul; Groh, Rainer M.J.</i> ) . . . . .	193
Evaluation of manufacturing defects in variable axial composites made by filament winding ( <i>Maciel, Maísa Milanez Ávila Dias; Guedes, Rui Miranda; Tita, Volnei</i> ) . . . . .	194
Design of variable stiffness composite plates using lamination parameter extrapolation and spectral-Chebyshev method ( <i>Khandar Shahabad, Peiman; Rafiei Anamagh, Mirmeyssam; Serhat, Gokhan; Basdogan, Ipek; Bediz, Bekir</i> ) . . . . .	195
MULTI-STABILITY ANALYSIS OF FRP METAMATERIALS ( <i>Risso, Giada; Ermanni, Paolo</i> ) . . . . .	195

**Author Index**



the following mechanical characterization of cut-out test specimens. For the microscopic analysis of the foam structure, polished specimens are prepared and examined under different microscopes. Furthermore, investigations with  $\mu$ -computed tomography are carried out to determine the porosity of the foam. The mechanical characterization is performed by means of tensile, compression and bending tests on suitable test specimens.

---

### **Development and characterization of in-situ sandwich panels with aluminum alloy foam core**

*Caldeira, Ana Sofia (sofiacaldeira@live.ua.pt), Department of Mechanical Engineering, Centre for Mechanical Technology and Automation (TEMA), University of Aveiro, Portugal*  
*Vesenjak, Matej (matej.vesenjak@um.si), Faculty of Mechanical Engineering, University of Maribor, Slovenia*  
*Carneiro, Vitor H. (vitorhcarneiro@hotmail.com), Department of Mechanical Engineering, CMEMS, University of Minho, Portugal*  
*Krstulović-Opara, Lovre (Lovre.Krstulovic-Opara@fesb.hr), Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture, University of Split, Croatia*  
*Duarte, Isabel (isabel.duarte@ua.pt), Department of Mechanical Engineering, Centre for Mechanical Technology and Automation (TEMA), University of Aveiro, Portugal*

abst. 1337  
**Room B035**  
Wednesday  
July 20  
12h10

The aluminum alloy foams have been explored to be used in energy absorption applications that require lightweight structures with high strength-to-weight and stiffness-to-weight ratios, high impact energy absorbing capacity, and good damping of noise and vibration. The metal foams are usually applied as core and/or as filler of sandwich panels and thin-walled structures. The purpose of this paper is to develop in-situ sandwich panels consisting of a highly porous aluminum foam core and aluminum alloy face sheets manufactured by the powder metallurgy method in which the face sheets are bonded to the foam core during the foam formation. The samples are geometrically analyzed in 2D and 3D using X-ray microcomputed tomography to extract morphological and topological properties of the foam core, the face sheets, and the bonding between them. The mechanical and acoustic properties of in-situ sandwich panels are evaluated.

---

### **Development and characterization of aluminum alloy foam – cork hybrid structures**

*Sousa, João D. P. (joaoduarte@ua.pt), Department of Mechanical Engineering, Centre for Mechanical Technology and Automation (TEMA), University of Aveiro, Portugal*  
*Pinto, Susana C. (scpinto@ua.pt), Department of Mechanical Engineering, Centre for Mechanical Technology and Automation (TEMA), University of Aveiro, Portugal*  
*Vesenjak, Matej (matej.vesenjak@um.si), Faculty of Mechanical Engineering, University of Maribor, Portugal*  
*Krstulović-Opara, Lovre (Lovre.Krstulovic-Opara@fesb.hr), Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture, University of Split, Croatia*  
*Carneiro, Vitor H. (vitorhcarneiro@hotmail.com), Department of Mechanical Engineering, CMEMS, University of Minho, Portugal*  
*Marques, Paula A.P. (paulam@ua.pt), Department of Mechanical Engineering, Centre for Mechanical Technology and Automation (TEMA), University of Aveiro, Portugal*  
*Duarte, Isabel (isabel.duarte@ua.pt), Department of Mechanical Engineering, Centre for Mechanical Technology and Automation (TEMA), University of Aveiro, Portugal*

abst. 1338  
**Room B035**  
Wednesday  
July 20  
12h30

Cellular solids and porous materials have been considered as one of the most suitable lightweight multifunctional materials for a wide range of commercial and industrial applications, e.g. in medicine, military. Their use contributes to an immediate and significant weight reduction and material savings of the components but also to multifunctionality due to their 3D cellular structures (open-cells or closed-cells). Herein, hybrid structures based on cellular materials are developed and studied by combining