

**Danubia-Adria Society on Experimental Methods (DAS)
Greek Society of Experimental Mechanics of Materials (GSEMM)**

**38th Danubia-Adria Symposium
on Advances in Experimental Mechanics**



Analytic Scientific Programme

**Poros, Greece
September 20-23, 2022**

38th Danubia Adria Symposium, 20-23 September 2022

Analytic Scientific Programme

Tuesday, September 20th, 2022

- 17:30 - 19:00 Registration (Amphitheater at Syggrou building)
19:30 Welcome Reception (Location: Amphitheater at Syggrou building)
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Wednesday, September 21st, 2022 (Amphitheater at Syggrou building)

08:15 - 08:45 Registration

08:45 - 09:15 Opening ceremony

Chair: Helmut Holl, Stefan Pastrama

- Welcome address by the Mayor of the Municipality of Poros Dr Giannis Dimitriadis
- Short overview of the Symposium by the President of the Local Organizing Committee, Professor Stavros Kourkoulis

09:15 - 10:15 **Oral Session I**

Chair: Dan Mihai Constantinescu, Josef Eberhardsteiner

ID 3224	Nikolaos D. Alexopoulos	<i>Greek Society of Experimental Mechanics of Materials, GSEMM</i>	Innovative nano-reinforced restoration materials: Design at the nanoscale, piezoresistive evaluation at the microscale and their production sustainability
ID 2841	Patrick P. Neumann, Harald Kohlhoff, Sergej Johann, Jessica Erdmann, Nicolas P. Winkler	<i>German Society of Experimental Stress Analysis, GESA</i>	The RASEM system: A technical overview
ID 2961	Kristóf Rácz, Rita M. Kiss	<i>Hungarian Scientific Society of Mechanical Engineering, GTE</i>	Anatomical landmark calibration wand accuracy for motion analysis
ID 3240	Lucian Gheorghe Gruionu, Răzvan Sabin Stan, Cristian Militaru, Anca Loredana Udriștoiu, Andreea Valentina Iacob, Mircea Cătălin Constantinescu, Constantin Militaru, Sebastian Militaru, Stefan-Dan Pastrama, Gabriel Gruionu	<i>Romanian Association for Stress Analysis, ARTENS</i>	A novel smart assisting robotic catheter for endovascular interventions

10:15 - 10:45 Coffee Break

10:45 - 11:50 **Poster Session 1 - BIOMECHANICS, BIOENGINEERING AND APPLICATIONS: Short presentations**

Chair: Rita Kiss, Vladimir Milovanović

ID 2934	Petra Adamović, Janoš Kodvanj, Predrag Knežević, Lovro Matoc	Implementation of the newly designed and experimentally validated locking system for treatment of favorable and unfavorable mandibular fractures
ID 3007	Libor Lobošský, Michaela Marešová, Tomáš Mandys, Jana Hluchá, Martin Salášek, Drahomíra Weisová, Tomáš Pavelka, Jiří Křen	Experimental and computational study on mechanical stabilization of sacral bone injuries
ID 3176	Stavros K. Kourkoulis, Athanasios Mitousoudis	The role of some critical biomechanical parameters on the stiffness of the Ilizarov external fixator
ID 2755	András Czétényi, Ilona Éva Lakatos, Brigitta Tóth, Rita Mária Kiss	Multilevel modelling of collagen tissues
ID 3174	Alexandra Ioannidou, Stavros Yannikakis, Chrysseis Caroni, Stavros K. Kourkoulis, Ermioni D. Pasiou, Anastasia Papavasileiou	Shear bond strength between CAD/CAM PMMA or conventional PMMA denture base and artificial teeth using different bond agents and tooth surface treatments
ID 3003	Emil Nutu, Stefan-Dan Pastrama, Lucian Gruionu, Dan-Mihai Constantinescu	Explicit dynamics simulation of the catheter movement during bronchoscopic sampling of pulmonary nodules
ID 3164	Ermioni D. Pasiou, Alexandros-Stergios Delapaschos	Long bones under three-point bending: The role of special feed on bone's mechanical properties
ID 3209	Zahir Shah, Rashid Jan, Narcisa Vrinceanu, Mihaela Racheriu, Wejdan Deeban	Dynamical behaviour of the fractional tumor-immune cells interactions model
ID 2874	Filip Pastorek, Zuzana Florková, Jana Pastorková	Enhanced phosphate coating for biomedical applications of biodegradable light alloys
ID 3223	Otis Wyatt, Panagiotis E. Chatzistergos, Ermioni D. Pasiou, Evi Ganniari-Papageorgiou	Experimental exploration of the optimum finite element modelling technique for non-pneumatic tyres used in wheelchairs
ID 3177	Erfan Maleki, Sara Bagherifard, Mario Guagliano	On the efficiency of gradient severe shot peening on fatigue behavior improvement of as-built laser powder bed fusion alsi10mg

11:50 - 12:35 **Poster Session 1 - BIOMECHANICS, BIOENGINEERING AND APPLICATIONS: Discussions**

12:35 - 13:30 **Lunch Break**

13:30 - 14:30 **Poster Session 2 - ADDITIVE MANUFACTURING AND OTHER MANUFACTURING PROCESSES: Short presentations**

Chair: Dimitrios Karalekas, Dimitrios Manolakos

ID 3099	Marino Brcic, Sanjin Krscanski, Josip Brnic	Experimental analysis of PLA printed heat treated specimens
ID 2985	Abdelmadjid Boualleg, David Cirkl	Experimental characterization of 3D printed composite material of AGILUS 30 and veroclear at different strain rates
ID 3183	Sylwia Rzepa, Martina Koukolíková, Matej Daniel, Jan Džugan	Mechanical behaviour of additively manufactured honeycomb lattice structures – Experimental, analytical and numerical approach
ID 2958	Hussein Alzyod, Lajos Borbas	Rapid prediction of the impact of printing parameters on the residual stress of FDM-ABS parts
ID 2999	Dimitrios Karalekas, Christos Kakalis, Maria Karna, Nikoleta Chatzidai, Charoula Kousiatza, Tatiani Tambouratzis	A combined experimental and artificial neural networks study of distortion of 3D printed beam structures
ID 3030	Jan Pokorný, Tomáš Návrat, Michal Vajdák	Wear measurement of the water-lubricated tilting-pad journal bearing: comparison of peek and cube materials
ID 3104	Paweł Maślak, Jerzy Czmochowski, Tadeusz Smolnicki	Strength and dynamic analysis of the component clamping system during turning machining
ID 2890	Michael Maier, Michael Pusterhofer, Florian Grün	Wear simulation in lubricated contacts considering wear-dependent surface topography changes
ID 3040	Johannes Diebold, Gerhard Wiesinger, Friedrich Bleicher	Cutting through mill scale of 1.2312 steel: Investigation of parameter influence for horizontal bandsawing
ID 3172	Gerhard Wiesinger, Stephan Famler, Lukas Weber, Johannes Diebold, Friedrich Bleicher	Influence of blade type and cutting parameters on kerf width in horizontal bandsawing of 42CrMo4
ID 3094	Constantina Matsika-Klossa, Dimitrios Karalekas, Nikoleta Chatzidai	Tensile properties of 3D printed carbon fiber reinforced nylon specimens
ID 3130	Alexandru Bârsan, Sever-Gabriel Racz, Radu Breaz, Mihai Crenganiş	Evaluation of the dimensional accuracy through 3D optical scanning in incremental sheet forming
ID 2887	Natalia Majca-Nowak, Paweł Pyrzanowski	DIC method in tensile strength tests on specimens printed in rigur in material jetting technology

14:30 - 15:15 **Poster Session 2 - ADDITIVE MANUFACTURING AND OTHER MANUFACTURING PROCESSES: Discussions**

and Coffee break

15:15 - 16:15 **Poster Session 3 - CONCRETE, MORTARS AND NANOCOMPOSITES: Short presentations**

Chair: Bernard Pichler, Anastasia Sotiropoulou

ID 2960	Karel Künzel, Kristýna Carrera, Václav Papež, Radoslav Sovják	The influence of fiber shape on non-destructive diagnostic of fiber-reinforced concrete
ID 3117	Anastasia Patrinoú, Eirini Tziviloglou, Zoi Metaxa	Graphene nanoplatelets and recycled milled carbon fibers hybrid composites for multi scale cement paste reinforcement
ID 3074	Pavel Horák, Radoslav Sovják, Šarka Pešková, Marcel Jogl, Petr Vítek	Investigation of cohesion between UHPC and normal strength concrete made from secondary materials
ID 3136	Georgios Tsonos, Sotiria Kripotou, Konstantinos Moutzouris, Ilias Stavrakas, Christos Tsonos, Dimos Triantis	Optical and dielectric properties of pure and nanofiber-composite polyurethane
ID 3191	Kristýna Carrera, Karel Künzel, Václav Papež, Radoslav Sovják	The effect of superplasticizer on mechanical properties of magnetically treated fiber reinforced concrete
ID 3188	Stamatia Gavela, George Karydis, George Papadacos, George Zois, Anastasia Sotiropoulou	Uncertainty of concrete compressive strength determination by a combination of rebound number, UPV and uniaxial compressive tests on cubic concrete samples
ID 3152	Eva Binder, Markus Königsberger, Rodrigo Díaz Flores, Herbert Mang, Christian Hellmich, Bernhard Pichler	Temperature-dependent creep of cement paste: From molecular properties to macroscopic experiments
ID 3182	Maria-Evangelia Stogia, Angeliki-Eirini Dimou, Nikolaos D. Alexopoulos	Investigation of multi-walled carbon nanotubes aqueous dispersions via electrical impedance spectroscopy
ID 3166	Evangelos Vasileiou, Lydia-Chara Pavlopoulou, Angeliki-Eirini Dimou, Andreas Andrikopoulos, Vasileios Zeimpekis, Nikolaos D. Alexopoulos	On the economic evaluation of restoration activities of modern monuments of cultural heritage with piezoresistive nanocomposites
ID 3151	Angeliki-Eirini Dimou, Lydia-Chara Pavlopoulou, Stavros K. Kourkoulis, Nikolaos D. Alexopoulos	Lime-based nanocomposites for masonry restoration: Implementation of the demonstrator and size effect on their piezoresistive behaviour
ID 3080	Nikolaos Nikoloutsopoulos, Anastasia Sotiropoulou, Dimitra Passa	Deep embedment and NSM techniques for shear strengthening of reinforced concrete with CFRP rope
ID 2855	Andronikos Loukidis, Antonios Kyriazopoulos, Ilias Stavrakas, Dimos Triantis	Acoustic and electrical emissions when cement mortars are subjected to axial compressive loading focusing in the vicinity of fracture

16:15 - 17:00 **Poster Session 3 - CONCRETE, MORTARS AND NANOCOMPOSITES: Discussions**

17:00 - 18:30 **Meeting of the Scientific Committee of the Danubia-Adria Society**

18:30 - 20:00 **General Assembly and Elections of the Greek Society of Experimental Mechanics of Materials (GSEMM)**

20:00 **Dinner (Location: Restaurant PRIMASERA, Punda, Poros)**

Thursday, September 22nd, 2022 (Amphitheater at Syggrou building)

08:30 - 09:30 **Oral Session II**

Chair: Zbigniew Kowalewski, Zvonimir Tomičević

ID 3122	Alen Grebo, Lovre Krstulović-Opara, Željko Domazet	<i>Croatian Society of Mechanics, HDM</i>	Thermal2DIC image to image translation with CycleGan and Pix2Pix
ID 3197	Bořek Ščerba, Tomáš Adamec, Tomáš Návrat	<i>Czech Society of Mechanics, CSM</i>	Validation of crack length measurement method with digital image correlation for fatigue tests
ID 3221	Marco Beghini, Tommaso Grossi, Ciro Santus	<i>Italian Association for Stress Analysis, AIAS</i>	Validation of a strain gauge rosette setup on a cantilever specimen: application to a calibration bench for residual stresses
ID 3153	Denisa Medvecká, František Nový, Petra Drímalová, Ondrej Štalmach	<i>Slovak Society of Mechanics, SSM</i>	Application of a high-speed infrared thermographic camera in the study of HAZ softening in S960 welded joints

09:30 - 10:30 **Poster Session 4 - PRACTICAL APPLICATIONS AND CASE STUDIES: Short presentations**

Chair: Robert Zemčík, Matthias Bartholmai

ID 3038	Radek Kottner, František Sedláček	Vacuum test of GFRP underground horizontal cylindrical tank
ID 3149	Zoltan Gabos, Zoltan Dombovari	Control-based continuation: Case study on a nonlinear slender beam structure
ID 2907	Piotr Steckowicz, Paweł Pyrzanowski	Multiframe fixture for gas turbine blade tip repair
ID 3167	Vasileios D. Prokopiou, Zoi S. Metaxa	Micro-oxydation of wine in ceramic vessels with CNT
ID 3046	Jacek Karliński, Mariusz Stańco, Paulina Działak	Experimental test of self-propelled bolting rig with a battery drive
ID 3200	Mateusz Melańczuk, Paweł Maślak	Determination of loads acting on the MTB bike with the use of accelerometers and strength calculations of the frame
ID 3234	Damian Derlukiewicz, Jacob Andruszko	Selected aspects of experimental-numerical research of a hybrid remotely controlled multi-tasking robot for construction work
ID 3045	Hendrik Hanes, Ilona Horwath	Operational and demand-oriented firefighting equipment
ID 2997	Nenad Kolarević, Miloš Stanković, Dimitrije Mihajlović, Nikola Davidović, Marko Miloš	Influence of elastic bearing support on labyrinth seal operation
ID 3018	Ivana Todić, Vladimir Kuzmanović	Investigation of the acceleration influence on friction in bearings in dual-spin missile
ID 2993	Jakub Durica, Premysl Kheml, Andrej Velas, Martin Boros	Effect of material hardness on delay time
ID 3179	Zoi Metaxa, Anastasios Rafailidis, Dimitrios Papaevaggelou, Efrosini Christodoulou, Athanasios Ekmektsis, Athanasios Mitropoulos	Cementitious demonstrator with graphene nanoplatelets for smart de-icing pavement applications
ID 3230	Jelena Živković, Vladimir Dunić, Vladimir Milovanović, Snežana Vulović, Miroslav Živković	Phase-field damage model for simulation of AA5083 behavior

10:30 - 11:15 **Poster Session 4 - PRACTICAL APPLICATIONS AND CASE STUDIES: Discussions**

and Coffee break

11:15 - 12:45 **Poster Session 5 - I. NEW SENSORS AND ACTUATORS, ADVANCED MEASUREMENT SYSTEMS**

II. MATHEMATICAL AND NUMERICAL TECHNIQUES: Short presentations

Chair: Thomas Lehmann, Marko Miloš

ID 3081	Zvonimir Tomičević, Ante Bartulović, Benjamin Smaniotto, François Hild	Influence of X-CT scanning parameters on DVC measurement uncertainty
ID 2883	Nicolas P. Winkler, Patrick P. Neumann, Erik Schaffernicht, Achim J. Lilienthal, Mikko Poikkimäki, Anneli Kangas, Arto Säämänen	Gather dust and get dusted: Long-term drift and cleaning of sharp GP2Y1010AU0F dust sensor in a steel factory
ID 2886	Tino Nerger, Patrick P. Neumann, Michael G. Weller	A new approach: Passive smart dust for detection of hazardous substances
ID 3032	Michael Melzer, Daniel Kreuter, Matthias Pelkner	Flexible giant magnetoresistance sensors for novel flux leakage testing capabilities
ID 3210	Sergej Johann, Nicolas P. Winkler, Matthias Bartholmai	Multi-sensor system for long-term monitoring with WiFi and LoRaWAN technology
ID 3125	Andras Bartfai, Zoltan Dombovari	Demonstration of optimal tuning measurement of the tuneable clamping table with a polymer workpiece
ID 3079	Fineas Morariu, Timotei Morariu, Sever-Gabriel Racz	Mobile robot vision navigation strategy based on Pixy2 camera
ID 3180	Robert Zemčík, Tereza Vaňková, Tomáš Kroupa	Strength analysis of fiber roving for multiscale modeling of hybrid carbon-aramid textile composite
ID 3207	Stavros K. Kourkoulis, Christos F. Markides, Ermioni D. Pasiou, Maria Stavropoulou	The actual boundary conditions in the flattened Brazilian-disc test
ID 2995	Attila Kossa, Daniel Bachrathy, Gabor Stepan	Modelling chip formation processes using the smoothed particle hydrodynamics method
ID 2998	Szabolcs Berezhvai, David Hajdu, Daniel Bachrathy, Gabor Stepan	Experimental validation of cutting force predictions for Ti6Al4V using CEL simulations
ID 3175	Christos F. Markides, Ermioni D. Pasiou, Stavros K. Kourkoulis	Towards an analytic solution for the intact semi-circular bend specimen
ID 2750	Alexandru Vasile, Iulian Constantin Coropețchi, Dan Mihai Constantinescu, Ștefan Sorohan, Catalin Radu Picu	Simulated annealing algorithms used for microstructural design of composites
ID 3106	Helmut J. Holl, Victoria Simader	Vibration amplitude reduction applying suitable variable excitation frequency
ID 3206	Christos F. Markides	Curing some drawbacks of the Brazilian-disc test by means of the circularly truncated Brazilian disc
ID 3171	Konstantinos E. Tsoutsouras, Emiliios Sideridis, Efsthios E. Theotokoglou	Analytical, experimental and computational study of composite beams in asymmetric four-point bending

12:45 - 13:30 **Poster Session 5 - I. NEW SENSORS AND ACTUATORS, ADVANCED MEASUREMENT SYSTEMS**

II. MATHEMATICAL AND NUMERICAL TECHNIQUES: Discussions

13:30 - 14:15 **Lunch Break**

14:15 **Excursion**

20:30 **Symposium Dinner (Location: Restaurant PRIMASERA, Punda, Poros)**

Friday, September 23rd, 2022 (Amphitheater at Syggrou building)

09:00 - 09:45 **Oral Session III**

Chair: Attila Kossa, Pawel Pyrzanowski

ID 3178	Elzbieta Pieczyska, Karol Golasifski, Jacek Janiszewski	<i>Committee for Mechanics of the Polish Academy of Sciences, KMPAN</i>	Influence of the strain rate on the mechanical and structure characterisation of gum metal
ID 3148	Luis Zelaya-Lainez, Giuseppe Balduzzi, Olaf Lahayne, Christian Hellmich, Markus Lukacevic, Josef Füssl	<i>Austrian Society of Experimental Strain Analysis, ASES</i>	Rudolf-Beer-Lecture: Micromechanics of non-embedded spruce wood: Novel polishing and indentation protocol
ID 2913	Dijana Damljanović, Djordje Vuković, Biljana Ilić, Goran Ocokoljić, Jovan Isaković, Marko Miloš	<i>Serbian Society of Mechanics, SSM</i>	High pitch sweep rates in supersonic wind tunnel tests

09:45 - 10:45

Poster Session 6 - EXPERIMENTAL CHARACTERIZATION OF MATERIALS I: Short presentations

Chair: Lovre Krstulović-Opara, Ermioni Pasiou

ID 3084	Zbigniew L. Kowalewski, Mateusz Kopeć, Adam Brodecki	Lights and shadows in applications of DIC and ESPI for damage evaluation of materials
ID 3208	Georgios Exadaktylos, Pantelis Liolios, Maria Stavropoulou	A web-driven platform of stress-strain monitoring of an underground marble quarry
ID 2894	Milan Růžička, Karel Doubrava, Martin Nesládek, Jiří Kuželka	Fatigue life improvement of the mixer shaft
ID 2941	Petr Hála, Alexandre Perrot, Barbora Vacková, Přemysl Kheml, Radoslav Sovják	Experimental and numerical study on ballistic resistance of polyurethane-coated thin HPFRC plate
ID 2966	Přemysl Kheml, Petr Hála, Alexandre Perrot, Barbora Vacková, Kristýna Carrera	A comparative study of ballistic resistance of conventional concrete, HPCC and next-generation sandwich structures
ID 2983	Petr Hála, Petr Konrád, Přemysl Kheml	Experimental analysis of freely-hanging laminated glass subjected to blast
ID 2955	Nikolaos Lengas, Sergej Johann, Daniel Kadoke, Karsten Müller, Eva Schlick-Hasper, Marcel Neitsch, Manfred Zehn	Damage assessment of complete, filled fibreboard boxes in regulative vertical impact tests by dropping
ID 2940	Catalin Adetu, Anton Hadar, Vasile Nastasescu, Alina Elena Adetu, Andrei Daniel Voicu, Stefan-Dan Pastrama	Ballistic protection plates for military helicopters structures: Experimental and numerical research
ID 3222	Vladimir Milovanović, Jelena Živković, Vladimir Dunić, Miroslav Živković	Experimental study of strain-rate-dependent behavior of aluminum alloy 5083-h321
ID 3243	Alessia Greco, Emanuele Sgambitterra, Franco Furguele	The nanoindentation technique for equi-biaxial residual stress measurement
ID 2933	Michael Schwaighofer, Luis Zelaya-Lainez, Markus Königsberger, Markus Lukacevic, Sebastián Serna-Loaiza, Olaf Lahayne, Valentin Senk, Josef Füssl	Characterization of elastic properties from technical lignins by light microscopy aided nanoindentation
ID 3041	Andrija Zaplatić, Zvonimir Tomičević, Juro Bilobrck, Petar Kosec, François Hild	Ex-situ simple shear of Arcan V-notched sample imaged via X-ray computed tomography

10:45 - 11:30

Poster Session 6 - EXPERIMENTAL CHARACTERIZATION OF MATERIALS I: Discussions

and Coffee Break

11:30 - 12:30 **Poster Session 7 - EXPERIMENTAL CHARACTERIZATION OF MATERIALS II: Short presentations**

Chair: František Nový, Milan Růžička

ID 3098	Konstantina D. Karantza, Dimitrios E. Manolakos	Crashworthiness behavior of thin-walled bimaterial tubes under axial collapse
ID 3204	Nikolaos A. Fountas, Stefanos Zaoutsos, Dimitrios Chaidas, John D. Kechagias, Nikolaos M. Vaxevanidis	Statistical modelling and optimization of mechanical properties for PLA and PLA/wood FDM materials
ID 3100	Laura Žiković, Gordan Jelenić	Experimental and numerical investigation of aluminium specimens with a circular hole subjected to tension
ID 2989	Chris Knisovitis, Antonios E. Giannakopoulos	The static anti-plane analogue in flexoelectric materials: Fiber pull-out
ID 3010	Thomas Lehmann, Edgar Peretzki, Jörn Ihlemann	A method for strain analysis around circular boundaries based on parametrization and optimized smoothing
ID 3035	Nicolae Stefanoaea, Adrian Marius Pascu	Study of implementation the tensile data of the glass fiber reinforced polyamide into the finite element analyses
ID 3039	Olivia-Laura Petraşcu, Adrian Marius Pascu	Comparative study of polyamide 6 (PA6) and polyamide 6 reinforced with glass fiber (PA6 GF30)
ID 3169	Ioannis Papantoniou, Helena Kyriakopoulou, Dimitrios Manolakos	Preliminary investigation of hydrogen embrittlement of friction stir processed AA5083 specimens
ID 3150	Rodrigo Diaz Flores, Valentin Donev, Mehdi Aminbaghai, Luis Zelaya-Lainez, Raphael Höller, Christian Hellmich, Martin Buchta, Lukas Eberhardsteiner, Bernhard L.A. Pichler	Multi-layered elastic analysis of an innovatively-equipped FWD field-testing site
ID 3037	Ana Vrgoč, Zvonimir Tomičević, Clément Jailin, François Hild	In-situ cyclic tension of glass fiber reinforced polymer: 3D full-field measurement over the entire loading history
ID 3170	Christina Margarita Charalampidou, George Grammatikos, Paraskevas Papanikos, Stavros Kourkoulis, Nikolaos D. Alexopoulos	Effect of corrosion exposure on the mechanical performance of aeronautical aluminum alloy 2024 riveted sheets
ID 3173	Nikitas Lourmpas, Konstantinos Bailas, Nikos Zacharopoulos, Paraskevas Papanikos, Demetris F. Lekkas, Nikolaos D. Alexopoulos	Marine plastic waste degradation study and recyclability prospects

12:30 - 13:15 **Poster Session 7 - EXPERIMENTAL CHARACTERIZATION OF MATERIALS II: Discussions**

13:15 - 13:45 **Award of Prizes and Closing ceremony**

Chair: Ilias Stavrakas, Adrian Marius Pascu

- Review of the symposium by the President of the Local Organizing Committee, by Professor Stavros Kourkoulis
- Announcements of the Scientific Committee of the Danubia-Adria Society, by Professor Helmut Holl, President of the Society

13:45 **Farewell lunch**

PHASE-FIELD DAMAGE MODEL FOR SIMULATION OF AA5083 BEHAVIOR

Jelena ŽIVKOVIĆ¹, Vladimir DUNIĆ¹, Vladimir MILOVANOVIĆ¹, Snežana VULOVIĆ², Miroslav ŽIVKOVIĆ¹

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1. Introduction

Authors successfully simulated behavior of S355 steel specimens in previous research [1] using a Phase-Field Damage Model (PFDM) coupled with plasticity by modifying the hardening function and the coupling variable. Two-intervals hardening function used in that research was modified in order to simulate the response of aluminum alloy (AA) structures as well [2]. Three AA5083-H321 flat specimens were investigated and results obtained after uniaxial tension tests were used for identification of material parameters necessary for numerical simulation. Obtained simulation and experimental results are compared and the good match is achieved.

2. Coupling of plasticity and phase-field damage model

Degradation function d for phase-field modeling of damage is proposed by [3] as $g(d) = (1-d)^{2p}$, where p represents the coupling variable. In this paper the coupling variable is modified in a way that its value is $p=0$ until the equivalent plastic strain reaches the critical value,

i.e. $\frac{\bar{\epsilon}_p}{\bar{\epsilon}_p^{crit}} < 1$, and in case that $\frac{\bar{\epsilon}_p}{\bar{\epsilon}_p^{crit}} \geq 1$, the coupling

variable is defined as $p = \frac{\bar{\epsilon}_p}{\bar{\epsilon}_p^{crit}} - 1$.

Fig. 1 shows theoretical stress-strain response of AA5083 as continuous line and it could be divided in two intervals. In the first interval, when $\bar{\epsilon}_p < \bar{\epsilon}_{p0}$, the yield stress can be defined by the linear hardening function parameter H_0 as

$\sigma_y = \sigma_{yv} + H_0 \bar{\epsilon}_p$. The second interval starts when $\bar{\epsilon}_p \geq \bar{\epsilon}_{p0}$ and there is a nonlinear increase of the stress which could be defined by Simo hardening function as

$$\sigma_y = \sigma_{y0} + (\sigma_{y0,\infty} - \sigma_{y0}) \left(1 - e^{-n(\bar{\epsilon}_p - \bar{\epsilon}_{p0})} \right) + H(\bar{\epsilon}_p - \bar{\epsilon}_{p0})$$

, where $\sigma_{y0} = \sigma_{yv} + H_0 \bar{\epsilon}_{p0}$. The influence of PFDM coupling with plasticity is shown as dashed line, and more details can be found in authors papers [1,2].

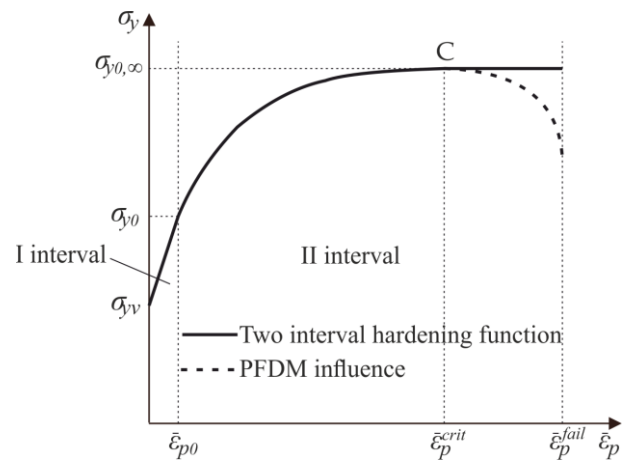


Fig. 1. Theoretical stress-strain response of AA5083.

3. Comparison of experimental and numerical results

Uniaxial tensile tests were conducted at room temperature for three AA5083-H321 flat specimens, with a strain rate of 10^{-3} s^{-1} . Fig. 2 shows those specimens after the tests.

Model used for FEM simulation was 1/8 of the gauge section of tested specimen. Geometrical imperfection was prescribed as a 0.01% linear decrease of width and thickness [2]. Displacement increment of 0.0025 mm was applied to the top surface nodes of the FE model. Table 1 shows the

material parameters used for PFDM simulation, obtained from real stress-real strain curve of one of the experimentally tested specimens and by calibration using the least squares method, where l_c is characteristic length-scale parameter, G_V is critical fracture release rate per unit volume, H is hardening modulus and n is hardening exponent.



Fig. 2. Three flat AA5083-H321 specimens after uniaxial tensile tests.

Table 1. Material parameters used in PFDM simulation of AA5083-H321 ductile behavior

E [MPa]	ν [-]	σ_{yv} [MPa]	$\sigma_{y0,\infty}$ [MPa]	H [MPa]	H_0 [MPa]
72133	0.33	206.65	414.93	95.63	8820
G_V [MPa]	n [-]	l_c [mm]	$\bar{\epsilon}_p^{crit}$ [-]	$\bar{\epsilon}_{p0}$ [-]	
3.273	18.1	0.01	0.14	0.0025	

Fig. 3 shows equivalent plastic strain field and damage field obtained by PFDM coupled with plasticity simulation at the displacement in y-axis of 8.6 mm. Distributions of both fields have similar character, so the occurrence of damage could be considered responsible for the start of fracture process. The evolution of both fields occurred in the necking zone of experimentally tested specimens.

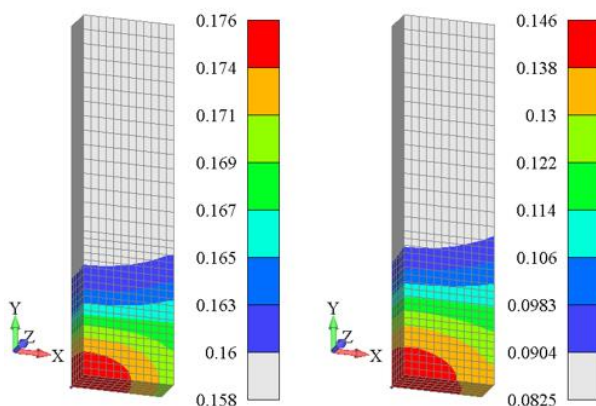


Fig. 3. Simulation results for effective plastic strain (left) and damage field (right).

Comparison of force-displacement diagrams obtained experimentally and by numerical simulations is shown in Fig.4. Two different FEM simulations were performed – by "pure" von Mises

plasticity model and by PFDM coupled with plasticity. It can be seen that the curve representing the force-displacement diagram obtained by PFDM + plasticity could reproduce the experimentally obtained response.

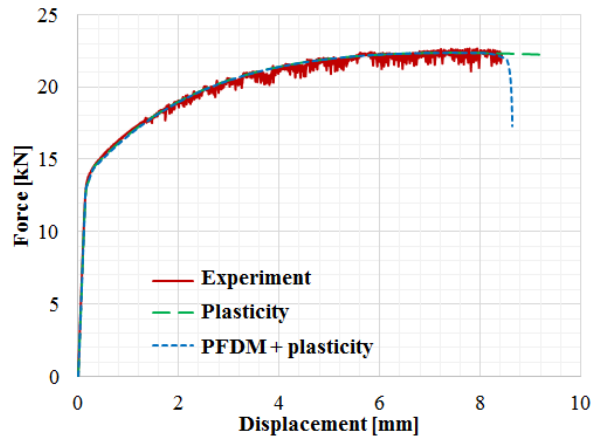


Fig. 4. Force-displacement diagrams obtained experimentally and by numerical simulations.

4. Conclusions

Proposed modification of two-intervals hardening function successfully simulated the response of AA5083-H321 by using PFDM coupled with plasticity. Numerical results were compared to the experimental ones obtained from uniaxial tensile tests on AA5083-H321 flat specimens and good match between force-displacement diagrams can be noticed. This and previous papers [1,2] show that PFDM coupled with plasticity can reproduce the experimental response for various materials.

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