ICSSM 2021
Proceedings

8th International Congress of the Serbian Society of Mechanics

June 28-30, 2021
Kragujevac, Serbia

Hellenic Society for Theoretical & Applied Mechanics (HSTAM)

СРПСКО ДРУШТВО ЗА РАЧУНСКУ МЕХАНИКУ
SERBIAN SOCIETY FOR COMPUTATIONAL MECHANICS

MINISTRY OF EDUCATION, SCIENCE AND TECHNOLOGICAL DEVELOPMENT

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The 8th International Congress of the Serbian Society of Mechanics Kragujevac, Serbia, June 28-30, 2021

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Organizers

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- **Faculty of Mechanical Engineering, University of Belgrade**
- **Faculty of Technical Science, University of Novi Sad**
- **Faculty of Mechanical Engineering, University of Niš**
- **Hellenic Society of Theoretical and Applied Mechanics**
- **Institute of Information Technology Kragujevac**
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- **Ministry of Education, Science and Technological Development**
- **Serbian Academy of Sciences and Arts**

and

- **Serbian Society of Computational Mechanics**

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Welcome Message

Dear colleagues,

It is a great pleasure for us to welcome you all at *the* ***8th International Congress of the Serbian Society of Mechanics*** in Kragujevac, Serbia Well-known for its culture, history and industrial heritage, Kragujevac was the first capital of modern Serbia and the place where the first constitution in the Balkans was proclaimed. Today, we are more than proud to say that Kragujevac is also becoming one of the scientific capitals in the region.

In this very difficult time of the COVID-19 pandemic, we decided to make this congress a hybrid event combining physical and online sessions, so that everyone interested can join us despite the obstacles we have all been facing for more than a year now.

8th International Congress of the Serbian Society of Mechanics aims to bring together leading academic scientists, researchers and research scholars to exchange and share experiences and research results on various aspects of *Theoretical and Applied Mechanics*. It will bring an interdisciplinary platform for researchers, practitioners and educators to present and discuss the most recent innovations, theories, algorithms, as well as practical challenges encountered and solutions adopted in the fields of *Classical Mechanics, Solid and Fluid Mechanics, Computational Mechanics, Biomechanics, Applied Mathematics and Physics, Structural Mechanics and Engineering.*

The Congress is organized by the Serbian Society of Mechanics (SSM) in partnership with: Faculty of Engineering, University of Kragujevac, Faculty of Mechanical Engineering, University of Belgrade, Faculty of Technical Science, University of Novi Sad, Faculty of Mechanical Engineering, University of Niš, Hellenic Society of Theoretical and Applied Mechanics, Institute of Information Technology Kragujevac, University of Kragujevac, with the support of the Serbian Ministry of Education, Science and Technological Development, Serbian Academy of Sciences and Arts and Serbian Society for Computational Mechanics.

Six distinguished plenary speakers will deliver lectures:

1. Prof. Georgios E. Stavroulakis – Technical University of Crete, Greece
2. Prof. Themis Exarchos – Ionian University, Corfu, Greece
3. Prof. Mihailo R. Jovanović – University of Southern California, USA
4. Prof. Ricardo Ruiz Baier – Monash University, School of Mathematics, Clayton, Australia
5. Dr Božidar Jovanović – MISANU, Serbia
6. Dr Marko Janev – MISANU, Serbia

The Congress encompasses six main topics: General Mechanics, Fluid Mechanics, Mechanics of Solid Bodies, Biomechanics, Control and Robotics, Interdisciplinary and Multidisciplinary Problems.

Also, there are four Mini-Symposia:

- M1: 5th Serbian-Greek Symposium on Advanced Mechanics
  Chairs: Prof. Georgios Stavroulakis, President of HSTAM, Greece; Prof. Nenad Filipović, President of SSM, Serbia
- M2: Turbulence
  Chair: Prof. Đorđe Čantrak, University of Belgrade, Serbia
- M3: Mathematical Biology and Biomechanics
  Chair: Dr. Anđelka Hedrih, MI SANU, Serbia
- M4: Nonlinear Dynamics
  Prof. Julijana Simonović, University of Niš, Serbia

Within the Congress, we are also very proud to organize the 5th Serbian-Greek Symposium on *Current and Future Trends in Mechanics*. The Symposium is organized by the Serbian Society of Mechanics (SSM) and the Hellenic Society of Theoretical and Applied Mechanics (HSTAM).

This year, *8th International Congress of the Serbian Society of Mechanics* received more than 150 high-quality research papers. Each paper was reviewed and ranked by at least 2 professors and scientists in the program and the scientific review committee. As a result of the strict review process and evaluation, the committee selected 120 research papers.

We must also say that the conference would certainly not have been so successful without the efforts of many people who were actively engaged in organization of such a major nationally and internationally recognized academic event. We give our special gratitude to the members of the program and scientific review committee as well as to all chairs, organizers and committee members for their dedication and support.

On behalf of the Organizing Committee, we wish you all a pleasant stay in Kragujevac and a productive conference.

Chairs:

Prof. Nenad Filipović, ***president of SSM, University of Kragujevac***
Prof. Miloš Kojić, ***Serbian Academy of Sciences and Arts***

Organizing Committee

Co-chairs:

- Nenad Filipović, president of SSM (University of Kragujevac)
- Miloš Kojić, (Serbian Academy of Sciences and Arts)

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Keynote Speakers

“Analysis of a New Mixed Formulation for Hyperelasticity Using Kirchhoff Stress”

Monday 28 June 2021

09:15 - 09:45

Prof. Ricardo Ruiz Baier,
Monash University, School of Mathematics,
Clayton, Australia

Abstract

Using the three-field formulation for nearly incompressible hyperelasticity introduced in [Chavan, Lamichhane, Wohlmuth, Comput. Methods Appl. Mech. Engrg. (2007), 196:4075-4086] we define a similar form valid for the fully incompressible case. We define a mixed finite element scheme and verify theoretical rates of convergence through computational tests. We also propose a new augmented Lagrangian preconditioner that improves convergence properties of iterative solvers. A few benchmark solutions are computed, and we test the formulation in models of cardiac biomechanics.

“Coronary Atherosclerosis Assessment: A New Anatomical, Functional, Morphological and Bio-mechanical Approach”

Monday 28 June 2021

15:00 - 15:30

Prof. Themis Exarchos,
Ionian University, Corfu, Greece

Abstract

Aims: To investigate and compare two different endothelial shear stress (ESS) calculation techniques, compare lesion specific smartFFR and ESS values, as well as total vessel smartFFR and ESS values, and investigate the relationship between smartFFR and ESS to stress MBF (myocardial blood flow) and MFR (myocardial flow reserve).

Methods: A total of 10 coronary vessels of 6 patients with intermediate pre-test likelihood for coronary artery disease who have undergone both CTCA and PET-MPI with 15O-water or 13N-ammonia were included in the study. Seven (7) cases had normal stress MBF and MFR values and three (3) had abnormal ones. PET was considered abnormal when > 1 contiguous segments showed both stress MBF ≤2.3mL/g/min and MFR ≤2.5 for 15O-water or <1.79 mL/g/min and ≤2.0 for 13N-ammonia, respectively. The ESS at the luminal surface of the artery was calculated as the product of viscosity and the gradient of blood velocity near the vessel wall. To calculate the smartFFR, we performed a transient simulation for each case. We used a pressure of 100 mmHg as a boundary condition at the inlet (i.e. mean human aortic pressure). At the outlet, a flow profile of 4 timesteps with a timestep duration of 0.25 sec was used. In each timestep, a volumetric flow rate of 1, 2, 3 and 4 ml/s are applied as outlet boundary conditions. The cut-off value for a pathological smartFFR is 0.83.

Results: There is a difference in total vessel calculated smartFFR results compared to the corresponding values of lesion specific smartFFR (0.88 vs 0.97, p=0.01). For ESS there is a negligible difference between lesion specific and total vessel values (2.22 vs 2.74, p = 0.9). There is a moderate negative correlation between both lesion specific (r = -0.543) and total vessel smartFFR and ESS (r = -0.915). ESS values were higher in vessels where vessel smartFFR was considered abnormal (1.97 vs 5.52, p = 0.01). Total vessel length smartFFR was lower in vessels with abnormal PET-MPI compared to the normal vessels (0.75 vs 0.93, p = 0.01). ESS is higher in vessels with pathological stress MBF and CFR (5.5 vs 2.0, p = 0.02)

Conclusion: The total vessel length smartFFR and lesion ESS appear to assess the functional significance of the vessel well, when compared to the PET-MPI measurements.

“Auxetic and other Metamaterials in Dynamics”

Tuesday 29 June 2021

08:30 - 09:00

Prof. Georgios E. Stavroulakis,
Technical University of Crete, Greece

Abstract

Microstructures are in several cases reponsible for the novel mechanical behavior. Materials with negative Poisson ratio, the so-called auxetics, constitute an interesting class of mechanical metamaterials with interesting applications in statics as well as in dynamics. For example, they have enhanced damping properties. Auxetics can be produced with star-shaped microstructures and perforations. These metamaterials can serve as a first example of novel materials with nonclassical properties. Mechanical properties are mainly considered here, while in a more general setting multiphysics applications are also possible.

A short review of auxetic microstructures and optimal design of corresponding metamaterials will be presented, in view of the flexibility provided by modern additive manufacturing techniques. Applications in statics, wave propagation and dynamics will be discussed. The numerical experiments of our group will be presented together with results of current published research.

Using a classical auxetic microstructure, possible applications are studied here through numerical simulation. Finite element models are developed and dynamic analysis numerical tests are considered. First, an application related to auxetic microstructures, which are intended to be used in the core of structural panels, is presented. Then, some numerical simulation for wind turbines blades, where aluminium foam, polymeric foam and the proposed auxetic material have been considered as the core material, are taken into account. The numerical results demonstrate that the usage of auxetic microstructures results in improved dynamic response of the system in comparison to traditional, conventional materials. Further considerations of optimal design problems can be followed, either by optimizing the parameters of one given auxetic microstructure, or by using more general topology optimization tools.

Optimal design may have several goals and restrictions, depending on the application. Dynamic behaviour may be studied in frequency or time domain. In addition a complete behaviour towards the appearance of band gaps is possible. Finally, novel concepts to enhance auxeticity and control the resulting behaviour have been proposed, namely contact-activated and piezoelectric controlled microstructures. Last but not least auxetics pose challenging tasks on homogenization, especially for dynamical behaviour.

Optimal design principles, emerging research needs and technological questions will also be discussed.

“Classical Neumann System on Stiefel Manifolds: Integrability, Geometric and Algebraic Aspects, and Linearization”

Tuesday 29 June 2021

15:00 - 15:30

Dr Božidar Jovanović,
MISANU, Serbia

Abstract

The Neumann system on a sphere is one of the basic classical examples of completely integrable systems. In this talk we give a review on the results concerning natural integrable generalizations of the Neumann systems to Stiefel manifolds [1,2,3,4]. Two Lax pairs for the systems are presented. A -matrix Lax representation enables us to prove non-commutative integrabilty of the Neumann systems, while a -matrix Lax representation implies a generalization of the Chasles theorem relating the trajectories of the systems and common linear spaces tangent to confocal quadrics. Also, by applying the second Lax representation we describe algebraic geometric properties of the systems. We show that generic complex invariant manifolds are open subsets of Prym varieties on which the flow is linear.

“Noether’s Theorem for Herglotz Type Variational Problems Involving Real and Complex Order Fractional Derivatives”

Wednesday 30 June 2021

08:30 - 09:00

Dr Marko Janev,
MISANU, Serbia

Abstract

In this work a variational principle of Herglotz type with a Lagrangian that depends on fractional derivatives of both real and complex orders is formulated, and the invariance of this principle under the action of a local group of symmetries is determined. By the Noether theorem the conservation law for the corresponding fractional Euler–Lagrange equation is obtained. A sequence of approximations of a fractional Euler–Lagrange equation by systems of integer order equations is used for the construction of a sequence of conservation laws. It is proved, that under certain assumptions, weakly converge to the one for the basic Herglotz variational principle. Namely, using the expansion of fractional derivative of a function into series, we analyze the approximations of already established Euler-Lagrange equation, infitezimal criteria and Noether’s type theorem, in a weak sense within the dual pairing of corresponding topological spaces.

“Color of turbulence: Stochastic Dynamical Modeling of Turbulent Flows”

Wednesday 30 June 2021

14:00 - 14:30

Prof. Mihailo R. Jovanović,
University of Southern California, USA

Abstract

This talk describes how to account for second-order statistics of turbulent wall-bounded shear flows using low-complexity stochastic dynamical models based on the linearized Navier-Stokes equations. The complexity is quantified by the number of degrees of freedom in the linearized evolution model that are directly influenced by stochastic excitation sources. For the case where only a subset of correlations is known, we develop a framework to complete unavailable second-order statistics in a way that is consistent with linearization around turbulent mean velocity. In general, white-in-time stochastic forcing is not sufficient to explain turbulent flow statistics. We develop models for colored-in-time forcing using a maximum entropy formulation together with a regularization that serves as a proxy for rank minimization. We show that colored-in-time excitation of the Navier-Stokes equations can also be interpreted as a low-rank modification to the generator of the linearized dynamics. Our method provides a data-driven refinement of models that originate from first principles and it captures complex dynamics of turbulent flows in a way that is tractable for analysis, optimization, and control design.

Program at a Glance

Monday 28 June 2021		
08:45 - 09:15	Opening Ceremony - Welcome speech: **Prof. Nenad Filipović**, President of SSM, Conference Co-Chair **Prof. Miloš Kojić**, full member of SASA, Conference Co-Chair **Nikola Dašić**, Major of Kragujevac City **Prof. Ivica Radović**, State Secretary, Ministry of Education, Science and Technological Development, Serbia **Prof. Dobrica Milovanović**, Dean of Faculty of Engineering, Kragujevac	
09:15 - 09:45	Keynote speaker: **Topic: Analysis of a New Mixed Formulation for Hyperelasticity Using Kirchhoff Stress** **Dr Ricardo Ruiz Baier,** *Monash University, School of Mathematics, Clayton, Australia*	
09:45 - 11:00	**Session M.1A** **Biomechanics (part I)**	**Session M.1B** **Mechanics of Solid Bodies (part I)**
11:00 - 11:30	Coffee Break	
11:30 - 13:00	**Session M.2A** **Interdisciplinary and Multidisciplinary Problems (part I)**	**Session M.2B** **Mechanics of Solid Bodies (part II)**
13:00 - 14:00	Buffet Lunch	
14:00 - 15:00	**Session M.3A** **Interdisciplinary and Multidisciplinary Problems (part II)**	**Session M.3B** **Mechanics of Solid Bodies (part III)**
15:00 - 15:30	Keynote speaker: **Topic: Coronary Atherosclerosis Assessment: A New Anatomical, Functional, Morphological and Bio-mechanical Approach** **Dr Themis Exarchos,** *Ionian University, Corfu, Greece*	
15:30 - 16:30	**Session M.4A** **General Mechanics (part I)**	**Session M.4B** **Mechanics of Solid Bodies (part IV)**
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17:00 - 18:30	**Session M.5** **General Mechanics (part II)**	

Tuesday 29 June 2021		
08:30 - 09:00	Keynote speaker: **Topic: Auxetic and other Metamaterials in Dynamics** **Dr Georgios E. Stavroulakis,** *Technical University of Crete, Greece*	
09:00 - 11:00	**Session T.1A** **Mini-Symposia I: 5th Serbian-Greek Symposium on Advanced Mechanics (part I)**	**Session T.1B** **Biomechanics (part II)**
11:00 - 11:30	Coffee Break	
11:30 - 13:00	**Session T.2A** **Mini-Symposia I: 5th Serbian-Greek Symposium on Advanced Mechanics (part II)**	**Session T.2B** **Biomechanics (part III)**
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14:00 - 15:00	**Session T.3A** **Mini-Symposia I: 5th Serbian-Greek Symposium on Advanced Mechanics (part III)**	**Session T.3B** **Control and Robotics**
15:00 - 15:30	Keynote speaker: **Topic: Classical Neumann System on Stiefel Manifolds: Integrability, Geometric and Algebraic Aspects, and Linearization** **Dr Božidar Jovanović,** *MISANU, Serbia*	
15:30 - 16:00	Coffee Break	
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Wednesday 30 June 2021		
08:30 - 09:00	Keynote speaker: **Topic: Noether's Theorem for Herglotz Type Variational Problems Involving Real and Complex Order Fractional Derivatives** **Dr Marko Janev,** *MISANU, Serbia*	
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10:45 - 13:00	**Session W.2A** **Fluid Mechanics**	**Session W.2B** **Mini-Symposia IV: Nonlinear Dynamics**
13:00 - 14:00	Buffet Lunch	
14:00 - 14:30	Keynote speaker: **Topic: Color of turbulence: Stochastic Dynamical Modeling of Turbulent Flows** **Dr Mihailo R. Jovanović,** *University of Southern California, USA*	
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Technical Program

Monday 28 June 2021

08:45 - 09:15	Opening Ceremony - Welcome speech: **Prof. Nenad Filipović**, President of SSM, Conference Co-Chair **Prof. Miloš Kojić**, full member of SASA, Conference Co-Chair **Nikola Dašić**, Major of Kragujevac City **Prof. Ivica Radović**, State Secretary, Ministry of Education, Science and Technological Development, Serbia **Prof. Dobrica Milovanović,** Dean of Faculty of Engineering, Kragujevac

09:15 - 09:45	Keynote speaker: Topic: **Analysis of a New Mixed Formulation for Hyperelasticity Using Kirchhoff Stress** **Prof. Ricardo Ruiz Baier**, Monash University, School of Mathematics, Clayton, Australia Chair: Hedrih A.

Session M.1A: 09:45-11:00

Biomechanics (part I)

Chairs: Kojić M., Geroski V.

M.1A.1 – Extension of our computational model for the left ventricle tissue to include hypertrophy – *Kojić M.*

M.1A.2 – Coupled Ohara-Rudy numerical model for heart electro-mechanics – *Geroski V., Milošević M., Milićević B., Simić V., Filipović N., Kojić M.*

M.1A.3 – Electromyography detection of muscle response in musculus quadriceps femoris of elite volleyball players on different exercises – *Radaković R., Peulić A., Kovač S., Simojlović M., Filipović N.*

Session M.1B: 09:45-11:00

Mechanics of Solid Bodies (part I)

Chairs: Mastilović S., Dunić V.

M.1B.1 – Remarks on discreteness of the nanoscale fragmentation mass distribution – *Mastilović S.*

M.1B.2 – Size-effect modeling of Weibull Jc cumulative distribution function based on a scaling approach – *Mastilović S., Đorđević B., Sedmak A.*

M.1B.3 – Material parameters identification of concrete damage plasticity material model – *Rakić D., Bodić A., Milivojević N., Dunić V., Živković M.*

M.1B.4 – Using of gap element for contraction joints modeling in seismic analysis of concrete arch dams – *Živković M., Jović N., Pešić M., Rakić D., Milivojević N.*

M.1B.5 – Finite element analysis of effects of multiple defects on welded joint integrity – *Aranđelović M., Sedmak S., Jovičić R., Sedmak A., Radaković Z.*

11:00 - 11:30	Coffee Break

Session M.2A: 11:30-13:00

Interdisciplinary and Multidisciplinary Problems (part I)

Chairs: Sedmak A., Nikolić D.

M.2A.1 – Noise induced dynamics of earthquake nucleation model – *Kostić S., Vasović N.*

M.2A.2 – Nonlinear landslide dynamics – *Kostić S., Vasović N.*

M.2A.3 – Computational mechanics – welding joint as a case study – *Jeremić L., Sedmak A., Sedmak S., Martić I.*

M.2A.4 – Experimental electrochemotherapy using novel design single needle device – *Cvetković A., Cvetković D., Milasinović D., Jovičić N., Miailović N., Nikolić D., Mitrović S., Filipović N.*

M.2A.5 – Cavitation diagrams for merchant ships using four blade b series propellers – *Veg M., Kalajdžić M.*

M.2A.6 – Microfluidic lab-on-chip system development for cell culture cultivation – *Milivojević N., Živanović M., Nikolić D., Jovanović Ž., Šeklić D, Nikolić M., Filipović N.*

Session M.2B: 11:30-13:00

Mechanics of Solid Bodies (part II)

Chairs: Rakić D., Obradović A.

M.2B.1 – New pipe ring tensile specimen for pipeline material fracture assessment – *Trajković I., Rakin M., Milošević M., Sedmak A., Međo B.*

M.2B.2 – Mass minimization of an AFG Timoshenko cantilever beam with a large body placed eccentrically at the beam end – *Obradović A., Mitrović Z., Zorić N.*

M.2B.3 – On concentrated surface loads and the flat punch contact problem in strain gradient elasticity – *Zisis T., Gourgiotis P., Georgiadis H.*

M.2B.4 – Geometric optimization of shaft transition zone based on stress-strain analysis of nature inspired design – *Atanasovska I., Momčilović D.*

M.2B.5 – A comparative analysis of fatigue behaviour between S355J2+N and Strenx 700 steel grade – *Živković M., Milovanović B., Dišić A., Jovičić G., Topalović M.*

M.2B.6 – Linear transient analysis of spatial curved Bernoulli – Euler beam using isogeometric approach – *Jočković M., Nefovska Danilović M.*

13:00 - 14:00	Buffet Lunch

Session M.3A: 14:00-15:00

Interdisciplinary and Multidisciplinary Problems (part II)

Chairs: Milošević M., Šušteršič T.

M.3A.1 – Analysis of atherosclerotic plaque in carotid arteries by using convolutional neural networks – *Arsić B., Đorović S., Anić M., Gakovć B., Končar I., Filipović N.*

M.3A.2 – Structural condition assessment and rehabilitation of 'Karpos' system bridge – *Milošević M., Živković S., Marković Branković J., Marković M.*

M.3A.3 – Epidemiological predictive modelling of COVID-19 spread – *Šušteršič T., Blagojević A., Cvetković D., Cvetković A., Lorencin I., Baressi Šegota S., Car Z., Filipović N.*

M.3A.4 – In vitro and in silico testing of stent device – *Nikolić D., Saveljić I., Filipović N.*

Session M.3B: 14:00-15:00

Mechanics of Solid Bodies (part III)

Chairs: Dunić V., Milovanović V.

M.3B.1 – Waves in composite layer reinforced with two families of inextensible fibres – *Milosavljević D., Radaković A., Čukanović D.*

M.3B.2 – Simulation of damage evolution in metal structures – *Živković J., Dunić V., Milovanović V., Živković M.*

M.3B.3 – Analysis of Hertz contact stresses for metallic material with carbides – *Atanasovska I., Momčilović D.*

M.3B.4 – Tuning a fractionally damped piezoelectric energy harvester with attached concentrated masses – *Paunović S.*

15:00 - 15:30	Keynote speaker: Topic: **Coronary Atherosclerosis Assessment: A New Anatomical, Functional, Morphological and Bio-mechanical Approach** **Prof. Themis Exarchos**, Ionian University, Corfu, Greece Chair: Filipović N.

Session M.4A: 15:30-16:30

General Mechanics (part I)

Chairs: Rakić D.

M.4A.1 – Design and practical realization of a frame with stiffness at its ending point – *Radomirović D., Kovačić I., Gatti G.*

M.4A.2 – Problematizing the orbital mechanics' two first integrals – *Nedić S.*

M.4A.3 – Simple algorithm for computing the stiffness matrix of composite cross-section – *Lazović Radovanović M., Nikolić J., Radovanović J.*

M.4A.4 – Topological interface states in acoustic metamaterials – *Cajić M., Karličić D., Adhikari S.*

Session M.4B: 15:30-16:30

Mechanics of Solid Bodies (part IV)

Chairs: Mićunović M., Anđelić N.

M.4B.1 – Low-cycle fatigue damage modeling with hysteretic energy loss – *Perović Z., Šumarac D.*

M.4B.2 – A model for the analysis of elasto-plastic buckling of compressed columns – *Milekić N., Bendić M., Ćorić S., Perović Z.*

M.4B.3 – On diffuse instability of orthotropic viscoplastic plates – *Kudrjavčeva Lj., Mićunović M.*

M.4B.4 – One view on the optimization of thin-walled cantilever channel-section and Z-section beams – *Anđelić N., Milošević Mitić V., Petrović A., Đurđević Đ.*

16:30 - 17:00	Coffee Break

Session M.5: 17:00-18:30

General Mechanics (part II)

Chairs: Nikolić D.

M.5.1 – Determination of dynamic load factor for single element camshaft using various laws of follower motion – *Jovanović Đ., Milenković B.*

M.5.2 – Behaviour, examination and stability of the constrained mechanical system described with nonlinear equations – *Vesović M., Radulović R.*

M.5.3 – Kowalevski exponents for the Kirchhoff equations – *Dragović V., Gajić B.*

M.5.4 – Added mass method application for dam-accumulation interaction analysis – *Rakić D., Jelić L, Živković M., Milivojević N., Bojović M.*

M.5.5 – Comparative bending analysis of composite laminate and functionally graded plates based on the new shape function – *Milosavljević D., Radaković A., Čukanović D., Bogdanović G., Ivanović L.*

M.5.6 – Vehicle motion in the presence of nonholonomic constraints – *Žigić M., Grahovac N.*

Tuesday 29 June 2021

08:30 - 09:00	Keynote speaker: Topic: **Auxetic and other Metamaterials in Dynamics** **Prof. Georgios E. Stavroulakis,** *Technical University of Crete, Greece* Chair: Kojić M.

Session T.1A: 09:00-11:00

Mini-Symposia I: 5th Serbian-Greek Symposium on Advanced Mechanics (part I)

Chairs: Filipović N., Kojić M.

T.1A.1 – Rolling without slipping a heavy homogeneous rigid ball on a torus – *Hedrih Stevanović K.*

T.1A.2 – Exact augmented perpetual manifolds: a corollary for their uniqeness – *Georgiades F.*

T.1A.3 – Effect of chiral materials on presence of band gaps – *Koutsianitis P., Tairidis G., Kougkolos A., Stavroulakis G.*

T.1A.4 – Viscoelastic fillers in cellular shear wall panels: behavior under dynamic loads – *Syrimi P., Papathanasiou S., Tsopelas P.*

T.1A.5 – Mathematical modelling of electro-elastic dislocations in piezoelectric materials and the J-integral – *Agiasofitou E., Lazar M.*

T.1A.6 – Free vibration of axially functionally graded Timoshenko cantilever beam with a large rigid body attached at its free end – *Obradović A., Šalinić S., Tomović A.*

T.1A.7 – A study of rectangular plates under colinear point load with both approximate and exact solution – *Tsiatas G., Pavlović M.*

T.1A.8 – Bullet penetration in auxetic star-shape armor plates – *Ntintakis I., Stavroulakis G.*

Session T.1B: 09:00-11:00

Biomechanics (part II)

Chairs: Kojić M., Marković Z.

T.1B.1 – Torsional oscillations of a tree trunk with branches through a biomechanical oscillatory model in the form of a complex cantilever – *Hedrih A., Hedrih Stevanović K.*

T.1B.2 – Inhibitory effect of coumarin derivate on vitamin K epoxide reductases (VKOR) responsible for anticoagulation effect – *Milanović Ž., Avdović E., Milenković D., Marković Z.*

T.1B.3 – Substituent effect on the binding mode and toxicity of selected 1,4-benzodiazepin-2-one – *Milanović Ž., Dimić D., Kesić A., Milenković D.*

T.1B.4 – Entresto (Sacubitril/Valsartan): molecular docking simulations with Neprilysin and Angiotensin II receptor – *Antonijević M., Marković Z., Filipović N., Đorović Jovanović J.*

T.1B.5 – Inhibitory effect of the 4-Hydroxy-(E)-N'-(1-(2,4-Dioxochroman-3-YL)Ethyl)-Benzohydrazide on the α-Glucosidase – *Antonijević M., Simijonović D., Avdović E., Đorović Jovanović J.*

T.1B.6 – Left ventricle model generated from echocardiographic data – *Milićević B., Milošević M., Geroski V., Simić V., Trifunović D., Filipović N., Kojić M.*

T.1B.7 – Fluid-electro-mechanical parametric model of the left ventricle – *Simić V., Milošević M., Milićević B., Geroski V., Filipović N., Kojić M.*

T.1B.8 – Numerical analysis of blood flow through the cerebral aneurysm – *Milovanović A., Saveljić I., Jovanikić O., Filipović N.*

11:00 - 11:30	Coffee Break

Session T.2A: 11:30-13:00

Mini-Symposia I: 5th Serbian-Greek Symposium on Advanced Mechanics (part II)

Chairs: Kojić M., Vulović A.

T.2A.1 – Analysis of freight wagons for transporting of bulk materials – *Vulović S., Pavlović D., Živković M., Vujanac R., Topalović M.*

T.2A.2 – Physics-informed neural networks for elastic plate problems – *Muradova A., Stavroulakis G.*

T.2A.3 – Crack analyses in a sandwich specimen under flexural loading – *Theotokoglou E., Tourlomousis I.*

T.2A.4 – Stochastic response of nonlinear energy sinks subjected to gaussian white noise base excitation – *Karatzia D., Tsiatas G.*

T.2A.5 – Ageing of equilibrium contact angle in capillary flows – *Lazaridis K., Wu Y., Muniyal Krishna S., Yu C., Krivilyov M., Sekulić D., Mesarović S.*

T.2A.6 – Calculation of femoral cortical bone elasticity modulus from computed tomography scans – *Vulović A., Filipović N.*

Session T.2B: 11:30-13:00

Biomechanics (part III)

Chairs: Milošević M., Đorović S.

T.2B.1 – Blood flow in arterial bifurcation calculated by turbulent finite element model – *Nikolić A., Topalović M., Simić V., Blagojević M.*

T.2B.2 – Analytical model: calculation of fractional flow reserve – *Starčević S., Savić S., Filipović N.*

T.2B.3 – Computational model for polymeric bioresorbable Poly-L-Lactic acid (PLLA) stents – *Milošević M., Anić M., Geroski V., Nikolić D., Isailović V., Filipović N., Kojić M.*

T.2B.4 – Computational modeling of tumor cell circulation in capillary with platelets – *Nikolić A., Simić V., Milošević M., Ziemys A., Yokoi K., Kojić M.*

T.2B.5 – Alterations of human articular cartilage due to osteoarthritis in terms of real and complex-conjugate derivatives – *Žigić M., Mikulić Gutman S., Grahovac N., Mitić I., Spasić D.*

T.2B.6 – Numerical analysis of knee joint at maximum power tennis serve – *Jovičić G., Vulović A., Đorović S., Vukićević A., Vulović R., Radaković R., Filipović N.*

13:00 - 14:00	Buffet Lunch

Session T.3A: 14:00-15:00

Mini-Symposia I: 5th Serbian-Greek Symposium on Advanced Mechanics (part III)

Chairs: Car Z., Simić V.

T.3A.1 – On inelasticity of damaged quasi rate independent orthotropic materials – *Mićunović M., Kudrjavčeva Lj.*

T.3A.2 – Artificial intelligence approach to parameter learning in nonlinear control systems – *Nestorović T., Pal A., Oveisi A.*

T.3A.3 – Determining inverse kinematics of a serial robotic manipulator through the use of genetic

programming – *Car Z., Baressi Šegota S., Anđelić N., Lorencin I., Musulin J., Štifanić D., Mrzljak V.*

T.3A.4 – Biomechanics of left ventricle and in silico drug testing – *Filipović N., Milićević B., Milošević M., Simić V., Georski V., Kojić M.*

Session T.3B: 14:00-15:00 **Control and Robotics** Chairs: Lazarević M., Obradović A.

T.3B.1 – H∞ proportional-integral control of a turbofan engine – *Zorić N., Jazarević V., Obradović A.*

T.3B.2 – PI velocity control of a mechanical system – *Živanović M.*

T.3B.3 – Robust constrained state space ILC for 3DOF robot manipulator – *Dubonjac A., Lazarević M.*

T.3B.4 – Adaptive iterative learning control of robotic system based on particle swarm optimization – *Živković N., Lazarević M., Petrović M.*

T.3B.5 – Open closed-loop PD\mu/PD type ILC control of neuroarm robotic system – *Cvetković B., Lazarević M., Mandić P., Šekara T., Lino P.*

15:00 - 15:30	Keynote speaker: Topic: **Classical Neumann System on Stiefel Manifolds: Integrability, Geometric and Algebraic Aspects, and Linearization** **Dr Božidar Jovanović,** *MISANU, Serbia* Chair: Lazarević M.

15:30 - 16:00	Coffee Break

16:00 - 18:00	**SSM Annual Meeting and Assembly 2021**

20:00 - 23:00	Gala Dinner - Restoran Di Trevi

Wednesday 30 June 2021

08:30 - 09:00	Keynote speaker: Topic: **Noether's Theorem for Herglotz Type Variational Problems Involving Real and Complex Order Fractional Derivatives** **Dr Marko Janev,** *MISANU, Serbia* Chair: Mađarević D.

Session W.1: 09:00-10:15

Mini-Symposia III: Mathematical Biology and Biomechanics

Chairs: Hedrih A., Simonović J.

W.1.1 – Volume optimization of the worm gear using biologically inspired algorithm – *Milenković B., Jovanović Đ.*

W.1.2 – Generalized function of fractional type dissipation energy in double DNA helix chain – *Hedrih Stevanović K.*

W.1.3 – Bone regenerative potential driven by periodic excitation: deterministic and stochastic mathematical models – *Simonović J., Woolley T.*

W.1.4 – Modelling the influence of externally induced cholesterol pulses on hypothalamic-pituitary-adrenal axis perturbed with ethanol – *Stanojević A., Anđelković M., Čupić Ž., Kolar Anić Lj.*

W.1.5 – Rotation transformation matrix of the joint coordinate system with the application to the knee joint – *Rosić N.*

10:15 - 10:45	Coffee Break

Session W.2A: 10:45-13:00

Fluid Mechanics

Chairs: Saveljić I., Topalović M.

W.2A.1 – Influence of second order effects on pressure distribution in microtubes – *Guranov I., Milićev S., Stevanović N.*

W.2A.2 – Simulating fluid flow within coronary arteries using parallelized sparse lattice Boltzmann method – *Đukić T., Filipović N.*

W.2A.3 – Saffman-Taylor instability - History and application – *Cvetković I., Milićev S., Pihler Puzović D.*

W.2A.4 – Multi-component mixture of Euler fluids - continuum/kinetic closure – *Pavić Čolić M., Mađarević D., Simić S.*

W.2A.5 – Multi-component mixture of Euler fluids - shock structure analysis – *Mađarević D., Pavić Čolić M., Simić S.*

W.2A.6 – FSI analysis of hydrofoils using FEM and SPH methods – *Topalović M., Nikolić A., Vulović S., Milovanović V.*

W.2A.7 – Natural convection due to lower plate temperature nonuniformity – *Jovanović M., Milanović S., Spasić Ž.*

W.2A.8 – Numerical simulation of laminar flow in periodical grooved channel – *Lečić L., Stevanović*

V.

W.2A.9 – Numerical modeling the motion of otoconia particles in the semicircular canal under whole body vibration – *Saveljić I., Mačužić Saveljić S., Nikolić D., Đukić T., Đorović S., Lukić J., Filipović N.*

Session W.2B: 10:45-13:00

Mini-Symposia IV: Nonlinear Dynamics

Chairs: Hedrih Stevanović K., Simonović J.

W.2B.1 – Schools of asymptotic methods on nonlinear mechanics Krilov-Bogolyubov-Mitropolsky and scientific research in Serbia – *Hedrih Stevanović K.*

W.2B.2 – Tracking of periodic signal through the orthogonal lattice of nonlinear chains by synchronisation – *Simonović J.*

W.2B.3 – Forced vibration of the nano-system composed from elastically connected nano-plate and nano-shell with influence of different parameters – *Stamenković Atanasov M., Pavlović I., Jovanović D.*

W.2B.4 – Exact augmented perpetual manifolds: corollary about linear and nonlinear perpetual mechanical systems – *Georgiades F.*

W.2B.5 – Nonlinear vibration of fractional viscoelastic beam on nonlinear layer – *Nešić N., Cajić M., Karličić D., Jović S., Simonović J.*

W.2B.6 – Analysis of evolution equations of a nonstationary axisymmetric body in a nonstationary central gravitational field – *Minglibayev M., Prokopenya A., Bizhanova S.*

W.2B.7 – Vibration suppression and energy harvesting application of an axially moving beam – *Karličić D., Cajić M., Adhikari S.*

W.2B.8 – Motion of two coupled bodies on a rough horizontal plane with variable coefficient of friction – *Prokopenya A.*

W.2B.9 – Finite-time stability of neutral fractional-order time-varying delay systems with nonlinear parameter uncertainties and perturbations – *Lazarević M., Radojević D., Maione G., Pisl S.*

13:00 - 14:00	Buffet Lunch

14:00 - 14:30	Keynote speaker: Topic: **Color of turbulence: Stochastic Dynamical Modeling of Turbulent Flows** **Prof. Mihailo R. Jovanović,** *University of Southern California, USA* Chair: Čantrak Đ.

Session W.3: 14:30-17:30

Mini-Symposia II: Turbulence

Chairs: Čantrak Đ.

W.3.1 – High efficiency optimization of a multistage centrifugal pump based on combination of modified BA and CFD – *Wang W., Pei J., Osman M.*

W.3.2 – Challenges to accurate computation of propeller performances at low angular velocities – *Svorcan J.*

W.3.3 – Energy harvesting from the hot water transportation pipelines – *Sonawat A., Kim J.*

W.3.4 – Experimentally determined response of impinging turbulent axisyimmetric air jet modified by low-amplitude sound modulation – *Cvetinović D., Erić A., Škobalj P., Milutinović N., Tihon J., Nakabe K., Tatsumi K.*

W.3.5 – Convolutional neural networks for flow sensing in wall turbulence – *Cuellar Martín A., Güemes A., Discetti S., Ianiro A.*

W.3.6 – TSI Presentation – *Sponsor presentation*

W.3.7 – Model-based design of riblets for turbulent drag reduction – *Jovanović M., Ran W., Zare A.*

W.3.8 – Sizing valve regulating element – *Savić Lj., Janković N., Čantrak Đ., Ilić D.*

W.3.9 – Simulating transitional and turbulent flow around airfoils at medium angles-of-attack – *Svorcan J., Hasan M., Tanović D., Popović L.*

W.3.10 – Five hole fast response probe for measurements of 3D velocity and pressure fields – *Bojović D., Čantrak Đ., Janković N., Nedeljković M.*

W.3.11 – Numerical investigation of reynolds number effects on rotor aerodynamic performances in hover – *Svorcan J., Kovačević A., Ivanov T., Jovanović M.*

W.3.12 – Forced vortex in turbulent swirling flow – *Čantrak Đ., Janković N., Lečić L.*

17:30 - 18:00	Closing Ceremony

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A COMPARATIVE ANALYSIS OF FATIGUE BEHAVIOR BETWEEN S355J2+N AND STRENX 700 STEEL GRADE

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Abstract:

Many engineering components in various branches of industry are subjected to fatigue loading. Steels still represent the most used group of mechanical materials for constructing bridges, buildings, ships, cars, rail vehicles, railways and etc. The most commonly used steel for producing carrying parts of structures, exposed to fatigue loads is mild-strength S355J2+N steel grade. The use of high-strength steels allows to design lighter and simpler structures. Nevertheless, using high-strength steels for increase yield strength of the steels does not correspond to a proportional increase of fatigue resistance. Therefore, application of high-strength steels for structures exposed to fatigue loading sometimes represents a major concern of the design and raises question of whether high-strength steels should be used or not. The purpose of this paper is to present a comparative analysis of the fatigue behavior between the mild-strength S355J2+N steel grade and high-strength STRENX 700 steel grade, investigated by an experimental program of uniaxial tension–compression stress-controlled fatigue test of smooth specimens.

Key words: Structural fatigue tests, fatigue life, S–N fatigue curves, S355J2+N steel grade, STRENX 700 steel grade

1. Introduction

Today steels represent the most used group of mechanical materials. Structural elements and structures made from steel are usually subjected to variable loads during their service (fatigue) life. Structural steels (S235, S275 and S355,) are the most widely used steels for structural elements and structures exposed to fatigue loads, because of their sufficient qualities and comparatively low price. In order to meet the requirements for the design of lighter and simpler structures with high structural performance, common occurrence is using of high-strength steels.

The S - N curves proposed in the design codes (EN 1993-1-9 [1] or EN 13001-3-1 [2]) do not show material dependence and it is necessary to determine exactly fatigue properties of various steel types. In general, fatigue behavior of structural steels is known more or less, but high-

strength steels are still less investigated and determination of their mechanical properties (fatigue) represent field of interest and investigation for many authors [3], [4], [5], [6].

This paper provides experimental assessment of the fatigue properties of two steels: mild-strength S355J2+N steel grade and high-strength STRENX 700 steel grade.

2. Approaches for fatigue test

Fatigue tests measure the resistance of materials to damage, losing strength and failure under the repeated application of load. The fatigue tests approaches are classified into S–N, *ε–N* and linear fracture mechanics approaches. The most well-known relations for description of fatigue behavior are: Equation (1) [7], [8], Equation (2) [8], [9] and Equation (3) [8], [10]:

$$\frac{\Delta\sigma}{2}=\sigma_a=\frac{\sigma_f'}{E}\left(2N_f\right)^b, \tag{1}$$

$$\frac{\Delta\varepsilon_p}{2}=\varepsilon_f'\left(2N_f\right)^c, \tag{2}$$

$$\varepsilon_a=\frac{\Delta\varepsilon}{2}=\varepsilon_{a,e}+\varepsilon_{a,p}=\frac{\Delta\varepsilon_e}{2}+\frac{\Delta\varepsilon_p}{2}=\frac{\sigma_f'}{E}\left(2N_f\right)^b+\varepsilon_f'\left(2N_f\right)^c. \tag{3}$$

In equations (1), (2) and (3) σ_a is true stress amplitude; $2N_f$ is the number of reversals to failure; σ_f', b are fatigue strength coefficient and fatigue strength exponent, respectively; ε_f', c are fatigue ductility coefficient and fatigue ductility exponent, respectively; $\varepsilon_a, \varepsilon_{a,e}, \varepsilon_{a,p}$ are the total, elastic and plastic strain amplitude, respectively; E is the Young's modulus.

For determination fatigue properties of the parent materials (S355J2+N and STRENX 700) global Stress-life (S–N) approach, based on Basquin model described in equation (1) was used. S–N approach is a global approach that relates the stress range and this approach is the basis of many standards for assessing the fatigue life, such as the Eurocode 3, part 1-9 [1]. For most stress-life calculations, the math is relatively easy, since there is only one stress component. S-N approach results relating directly a global definition of stress range (stress amplitude) to the total number of reversals to failure. Often, Basquin's equation - equation (1) is adopted for representing the Wöhler curve as a straight line in a double logarithmic plot.

3. Experiment

2.1 Description of investigated materials

The materials chosen for this experimentally study are mild-strength S355J2+N steel grade and high-strength STRENX 700 steel grade. Table 1 shows chemical composition for both steels [11], [12]. Both steels are steels for welding; but the weldability of the high-strength steel is in general poorer than the weldability of mild-strength steel due to the higher level of alloy elements.

Steel grade	C	Si	Mn	P	S	Cr	Ni	Mo	Cu	N	Al	Nb	V	Ti
S355J2+N	0.161	0.046	1.488	0.0224	0.0086	0.040	0.014	0.05	0.005	0.004	0.049	-	-	-
STRENX 700	0.11	0.093	0.64	0.009	0.017	-	-	-	-	-	0.017	0.088	0.19	0.14

Table 1. Comparison of the chemical composition between the S355J2+N and STRENX 700 steel grades (wt %)

Uniaxial tensile tests are investigated at room (23±5 °C) temperature using servo-hydraulic testing machine SHIMADZU type EHF EV101K3-070-0A (Shimadzu Corporation, Tokyo, Japan), with force ±100 kN and stroke ±100 mm. The uniaxial tensile tests are carried out in accordance to EN ISO 6892-1 [13], ASTM E8M-01 [14] and ASTM E646-00 [15] in constant stroke control rate of 4mm/min. For determination of Young modulus and elongation measurement the extensometer MFA25 (MF Mess & Feinwerktechnik GmbH, Velbert, Germany) with gauge length of 50mm is used.

Fig. 1 shows stress–strain curves that were obtained for the S355J2+N and STRENX 700 steel grades as results of performed uniaxial tensile tests. The mechanical properties for the S355J2+N and STRENX 700 steel grades are shown in Table 2.

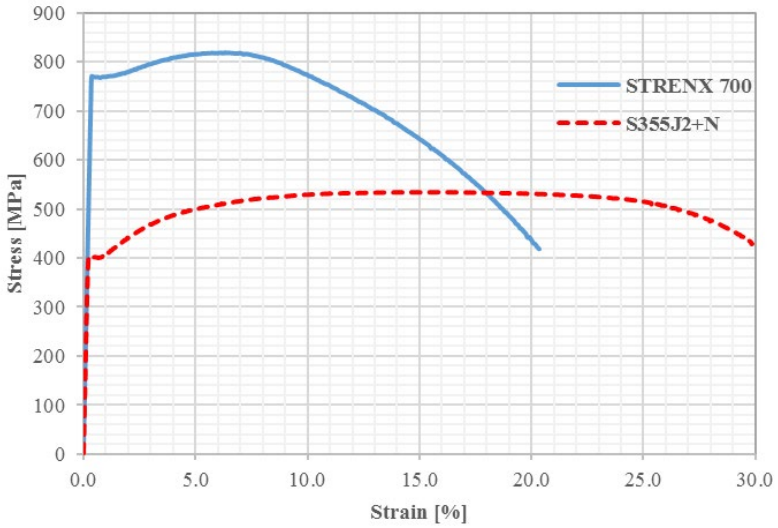


Fig. 1. Stress–strain curves - Typical yielding and strain hardening behaviors of the S355J2+N and STRENX 700 steel grades

Steel grade	Yield strength σ_y [MPa]	Tensile strength σ_u [MPa]	Young modulus E [GPa]	Tensile strain-hardening exponent n [-]	Strength coefficient K [MPa]
S355J2+N	401.24	539.36	206.26	0.2129	920.49
STRENX 700	767.97	818.08	228.89	0.0509	992.67

Table 2. Comparison of the mechanical properties between the S355J2+N and STRENX 700 steel grades

Nevertheless, the curves allow the comparison of the yield region of both steels as well as the initial strain hardening behaviour. It is clear that the S355J2+N steel shows a yield plateau, after which a very significant strain hardening is verified. The STRENX 700 steel does not show that yield plateau, and a relatively small strain hardening is observed.

2.2 Fatigue experimental method

The aim of this research is to compare the fatigue behaviour between the mild-strength S355J2+N steel grade and high-strength STRENX 700 steel grade, based on experimental results from fatigue tests of smooth specimens. A complete fatigue characterization of the mild-strength S355J2+N steel grade and high-strength STRENX 700 steel grade, carried out according to the internal procedures of the Centre for engineering software and dynamic testing at Faculty of

Engineering University of Kragujevac using servo-hydraulic testing machine SHIMADZU type EHF EV101K3-070-0A (Shimadzu Corporation, Tokyo, Japan), with force ±100 kN and stroke ±100 mm.

Determination of fatigue properties for the mild-strength S355J2+N steel grade and high-strength STRENX 700 steel grade was performed on specimens at room (23±5ºC) temperature. One series of 15 specimens were prepared for each material. All specimens have finely polished to minimize surface roughness effects.

Material fatigue properties of the mild-strength S355J2+N steel grade and high-strength STRENX 700 steel grade, due high cycle load, were obtained under uniaxial, fully reversed (tensile-compression) testing with R=-1 stress ratio. Specimens were exposed to high cycle fatigue under stress-controlled conditions in accordance to ASTM E468-90 [16]. During the fatigue properties testing frequency was 10-15 Hz.

3. Results and discussions

The results of the experimental fatigue tests on smooth specimens for the mild-strength S355J2+N steel grade and high-strength STRENX 700 steel grade are shown in Table 3.

	S355J2+N			STRENX 700		
Specimen designation	Stress amplitude σ_a, [MPa]	Frequency, [Hz]	Number of cycles N_f	Stress amplitude σ_a, [MPa]	Frequency, [Hz]	Number of cycles N_f
1	350	10	12800	540	10	9850
2	350	10	14500	540	10	11200
3	350	10	18300	540	10	8950
4	310	10	25800	500	10	30150
5	310	10	40300	500	10	21800
6	310	10	53200	500	10	49050
7	280	10	62700	450	10	69200
8	280	10	93600	450	10	80650
9	280	10	112900	450	10	130650
10	250	15	130700	400	15	141300
11	250	15	109700	400	15	364700
12	225	15	352900	350	15	483150
13	225	15	371000	350	15	566300
14	200	15	1562000	300	15	1430050
15	200	15	2000000	300	15	2000000

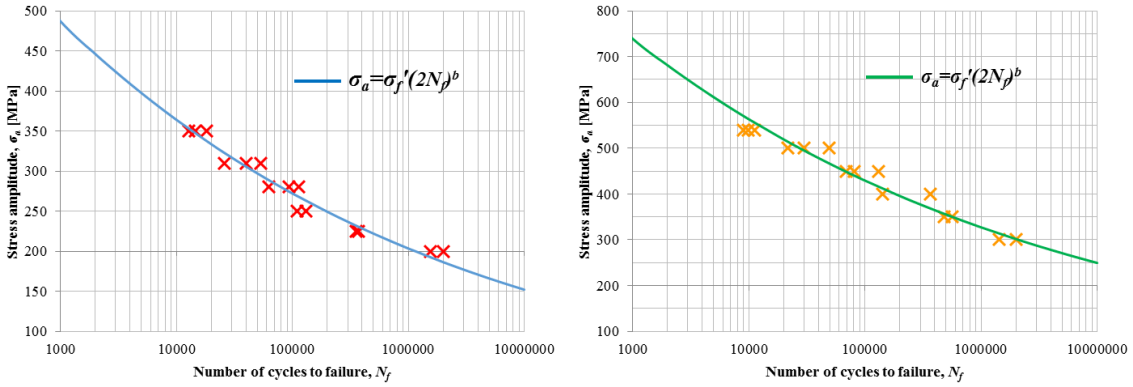
Table 3. Fatigue test results under stress-controlled conditions

The S–N curve is a basic curve for characterizing the fatigue properties of the material. According to the experimental data from Table 3, Basquin model described in equation (1) and statistical analysis according to standard ASTM E739-91 [17], fatigue properties of the mild-strength S355J2+N steel grade and high-strength STRENX 700 steel grade are determined and shown in Table 4.

Based on experimentally obtained uniaxial tension–compression stress controlled mechanical properties of S355J2+N steel grade and STRENX 700 steel grade S-N curves (semi-log representation), have been determined and shown in Figure 2. Figure 3. compares the S-N curves between the mild-strength S355J2+N steel grade and high-strength STRENX 700 steel grade, investigated by an experimental program of uniaxial tension–compression stress-controlled fatigue test of smooth specimens.

Steel grade	Fatigue strength coefficient $\sigma_{f'}$ [MPa]	Fatigue strength exponent b [-]
S355J2+N	1274.39	-0.1264
STRENX 700	1814.61	-0.1181

Table 4. Fatigue properties under uniaxial stress-controlled fully reversed testing, stress ratio R=-1



a) b)

Fig. 2. Semi-log S-N curve for uniaxial stress controlled smooth specimens a) S355J2+N steel grade, b) STRENX 700 steel grade

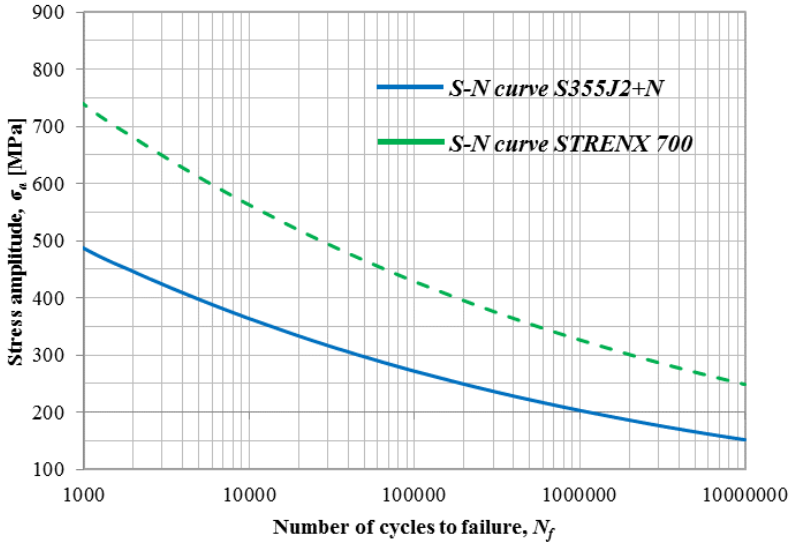


Fig. 3. Comparison of the S-N curves between S355J2+N and STRENX 700 steel grades

The calculated $\Delta\sigma_c$ (reference value of the fatigue strength at N_C = 2 million cycles) level of the S355J2+N steel grade is about the same as class 160 of EN 1993-1-9 [1]. The obtained results of the STRENX 700 steel grade show a fatigue behavior similar to the S355J2+N steel grade. The calculated $\Delta\sigma_c$ level of the STRENX 700 steel grade is much higher than the S355J2+N value.

4. Conclusions

The fatigue behavior between the mild-strength S355J2+N steel grade and high-strength STRENX 700 steel grade were investigated by an experimental program of uniaxial tension–compression stress-controlled fatigue test of smooth specimens. For considered high cycle fatigue regime and obtained S-N curves for both materials, the STRENX 700 steel grade shows similar

fatigue behavior, but, due to its superior yield strength, STRENX 700 steel grade shows higher fatigue resistance than the S355J2+N steel grade. As a concluding remark, the design of structural details with high-strength steels (STRENX 700 steel grade) should take advantage of the superior resistance of these steels to static and service (fatigue) loads. The utilization of high-strength steels increases the fatigue sensitivity of the structural detail with respect to details made of structural (mild-strength) steels.

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