UDK: 531:061.3(047)
COSATI: 20-11

1st ICSSM — International Congress of the Serbian Society of Mechanics

Stevan Maksimović, PhD (Eng)[1)]

THE *First International Congress of the Serbian Society of Mechanics (ICSSM)* was held 10 - 13 April, 2007 at Kopaonik. This congress is the successor of a series of YU Congresses and it is actually 26th YU Congress of Mechanics.

The Congress is organized by the Serbian Society of Mechanics, under the auspice of the Ministry of Science and Environmental Protection of the Republic of Serbia (MNTR) and is supported by the Serbian Chamber of Engineers.

The papers, contributed by authors from all around the globe, have been divided into 10 sections which cover the 'Plenary lectures', 4 main areas of interest, i.e., sections A, B, C and D and five Minisimposia.

Objectives

The increasing necessity to solve complex problems in Theoretical and Applied Mechanics requires the development of new ideas and innovative methods. The purpose of the Congress is to bring together the scientific communities of Theoretical and Applied Mechanics in an effort to facilitate the exchange of ideas in topics of mutual interests and to serve as a platform for establishing links between research groups with complementary activities. The community of Theoretical and Applied Mechanics will benefit from this interaction, introducing advanced methods which can highly assist in tackling complex mechanical problems.

Congress Topics:

Section A: General Mechanics
Section B: Fluid Mechanics
Section C: Mechanics of Solid Bodies
Section D: Interdisciplinary and Multidisciplinary Problems

Minisimposiums:

M1: Computational Methods in Structural Analysis and Optimization by FEM, Organized by Stevan Maksimović
M2: Biomechanics, Organized by Nenad Filipović
M3: Mathematical Methods in Mechanics, Organized by Vladimir Dragović
M4: Geometry in Physics, Organized by Milan Mićunović
M4: Fracture Mechanics Applications in Structural Integrity Assessment, Organized by Stojan Sedmak

Plenary Lectures

1. Application of Mechanics in Engineering Sciences and Practice – The State of the Art and Perspective, Nikola Hajdin
2. A Generalized Ritz Method for Partial Differential Equations in Domains of Arbitrary Geometry using Global Shape Functions, John Kastikadelis
3. Applications of Fractional Calculs in Mechanics, Teodor Atanacković and Vladan Đorđević
4. On the Effects of Geometry on Guided Electromagnetic Waves, Robin Tucker

Invited Lectures

1. Hybrid System Dynamics (Section A), Katica R. (Stevanović) Hedrih
2. Dynamics of the system with Discontinual Mass Variation (Section C), Livija Cvetičanin
3. On the Issue of Multiscale Robustness in Computational Mechanics (Minisymposia M1), Dubravka Mijuca
4. Modelling of Ultrasonic Guided Wave Propagation in Long Bones (Minisymposia M2), Vasilios Protopappas, Maria Vavva, Dimitrios Fotiadis, Konstantinos Malizos, D. Polyzos
5. Dynamics and Geometry of Integrable Billiard Systems (Minisymposia M3), Vladimir Dragović
6. Structural Integrity – A Problem of Cracked Components (Minisymposia M5), Stojan Sedmak

The Presidency of the Serbian Society of Mechanics decided to have the best young authors awarded.
Propositions for "Rastko Stojanović" Award:
– Author should be younger than 35.
– The article should be a single author paper.
– Paper should be presented at the Congress.

Figure 1. Ivana Ilić from VTI as the best young author has received the "Rastko Stojanović" award

[1)] Military Technical Institute (VTI), Ratka Resanovića 1, 11132 Belgrade, SERBIA

Two young authors (Katarina Kukić and Ivana Ilić) were awarded during this Congress at Kopaonik.

VTI Presentations

Stevan Maksimović, Zijah Burzić, Vladan Veličković, Ivana Ilić, Marko Bojanić, and Dejan Malobabić from the Military Technical Institute (VTI) presented their own papers as well as the papers of their absent colleagues.

– *An efficient optimization method to minimum weight design of large-scale structural systems* (S.Maksimović, VTI, Belgrade)

An efficient optimization method is presented for minimum weight design of the large-scale structural system such as aircraft structural systems. The efficiency of the method is based on application of the two-level approach in structural optimization structural systems. This approach breaks the primary problem statement into a system level design problem and set of uncoupled component level problems. Two-level optimization approach is applied to structural design problems like: minimum weight of the complex aircraft composite structure under various strength and stiffness constraints.

Optimization method presented here is based on combining optimality criterion (OC) and nonlinear mathematical programming (NMP) algorithms. Finite element analysis (FEA) is used to compute internal forces at the system level. The local stress and local initial failure load in each independent element are defined as component constraints. The use of the NMP algorithm is essential to two-level approach and local level, since it can handle the highly nonlinear component problem, such as local buckling or special initial failure constraints in the mechanical fastened joints. The two-level optimization approach is applied to minimum-weight design of complex aircraft structures such as aircraft parachute composite beam subject to multiple constraints.

– *Structural analysis of torodial containers for liquefied petroleum gas* (V.Veličković, VTI, Belgrade; M.Bojanić, VTI, Belgrade, A.Grebović, "LIFAM M" d.o.o., Stara Pazova)

The structural analysis of the three types of torodial containers for liquefied petroleum gas (LPG), designed and manufactured by the firm "Lifam M" from Stara Pazova (Serbia), were made in the Aircraft Strength Department of the Military Technical Institute (VTI). The types differ in the outer diameter.

The paper discusses the most important steps as well as the main results of the structural analysis of the LM-630 container type.

The structural analysis should demonstrate that the container satisfies the design requirements regarding strength. These requirements are defined in the Annex 10 of the document ECE Regulation No. 67 Revision 1.

All parts of the container were modelled using plate elements (CQUAD4) and first analysis was performed for the test pressure using MSC/NASTRAN software package. The essential part of the analysis was obtaining the optimal shape of the container's cross section which would satisfy technical requirements as well as requirements of fabrication.

After that, the structural analysis of the container with the optimal cross section was performed for the bursting pressure. The obtained results showed that the design requirements were satisfied in both cases for all elements of the container.

The entire procedure was repeated for other two types of containers.

The final conclusion based of the performed structural analysis was that all types satisfy the technical requirements regarding the carrying capacity of the container.

– *Determination of shaped charge jet stress and deformation state caused by angular velocity* (M.Ugrčić, VTI, Belgrade)

The angular velocity of the shaped charge jet around axial symmetry axis during activation of the shaped charge warhead, especially in the gyroscopic stabilised projectiles, causes intensive changes of the internal stress and deformation state in the jet material. The radial rupture of the shaped charge jet appears under high values of the angular velocity that has negative consequences on the effectiveness of the warhead, due to the drastic penetration reduction. In this way, the qualitative and quantitative determination of the stress and deformation state in the jet material is a very important input parameter to design and optimise the shaped charge. The computation of the stress and deformation in some segments of the shaped charge jet, with low values of the angular velocities of the projectile, by the finite element method was carried out.

– *Stress analysis of abutment tooth with conus telescope crown by finite elements* (M.Zeljković, Military Medical Academy-Belgrade, S.Maksimović, VTI-Belgrade, V.Zeljković, Institute of Technical Science - Belgrade)

This work investigates the behaviour of abutment tooth with conus telescope crown on the first lower premolars. The finite element method (FEM) was applied to analyze stresses in this system. The paper includes a problem formulation: geometric model description, anisotropy material modelling, description the contact problem and defining applied loads. The effects of the height of supporting alveolar bone on the resulting force distribution on the periodontal membrane were also investigated. Special attention in this investigation is given to the modelling of the periodontal membrane. The effects of periodontal membrane on the stress distributions at the tooth are described. Some practical conclusions, for denture system protection, are obtained.

– *Geometric and material nonlinear behaviour of shell type structures by finite elements* (M.Bojanić, VTI, Belgrade)

An inelastic material model for isotropic plates and shells is considered. A finite element model that accounts for both geometric and material nonlinearities is included. The elasto-plastic material behaviour is incorporated using cyclic behaviour of the material. This model can be efficiently used for fatigue life estimation of notched structural components under cyclic loads up to crack initiation at the critical part. The effects of material orthotropy on geometric nonlinear behaviour are also analyzed. For this purpose, high-quality 4-node shell finite elements are used. Present finite element solutions are compared with available analytic, numerical and experimental results. Numerical examples demonstrate the validity of the computation procedure in domains' geometric and material nonlinear problems.

– *Optimal design of structural components modelled by finite elements* (D.Malobabić, VTI, Belgrade)

There are essentially two motivating factors for developing structural optimization capabilities. The more obvious of the two is to increase the productivity of the structural designer by automating for him the otherwise tedious, repetitive and time-consuming manual design changes towards a design that is often only satisfactory, but not necessarily optimum. This work considers minimum weight design of the structural components modelled by

finite elements. To solve the optimization problem, optimality criteria methods [1-3] are used. The potential strength of the method is that the number of iterations needed for converging to an optimum is virtually independent of the number of structural members [2]. This property makes this method well suited for the optimum sizing of large practical structures. To efficiently illustrate this optimization procedure, minimum weight design of aircraft components is analysed.

– *Failure Analysis of composites containing FE contact problem* (I.Ilić, VTI, Belgrade)

This paper considers the strength of layered components containing pin-loaded holes. The investigation is focused on developing reliable computation procedure to analyze initial failure load for pin-loaded holes at the layered composite structures. Finite element method (FEM) is used to determine stress distribution around the fastener hole. Combining Chang-Scott-Springer characteristic curve model and Tsai-Wu initial failure criterion are used to determine the joint failure. In this work, special attention is given to pin-load distributions and their effect on the load level of failure and its location. In previous works, initial failure analysis was carried out using cosine distribution between pin/lug mechanically fastened joints. Here, contact finite element pin/lug model is analysed. The influence of stacking sequences of layered composites containing pin-loaded holes is also investigated. The computation results are compared with the available experimental results and good correlations obtained.

– *Analysis of fatigue crack growth using energy parameters* (S.Boljanović-VTS Belgrade, S.Maksimovic VTI Belgrade, Jan Zuidema- Delft University of Technology, Netherlands and Ilija Belic-VTS Belgrade)

In the present investigation, low cycle fatigue behaviour is studied using strain energy density. The strain energy density theory enables analysing crack growth rate. Analytical method is used to calculate the stress intensity factor as well as the finite element technique. Presented model offers a reliable fatigue crack growth prediction for structural elements with complex geometry and arbitrary loading. The validity of the model is established for structural elements such as Compact Tension specimen. In this paper, a comparison is made between the presented model and Paris model for considered specimens with experimental data. The findings show agreement between predictions about the presented model and available experimental results.

– *Fatigue behavior of alloyed steel for high temperature* (M.Burzić, Institute GOŠA d.o.o Belgrade, Z.Burzić, VTI-Belgrade, J.Kurai- NIS Petrol Pančevo, Dž.Gačo- University of Bihać)

This work considers fatigue behaviour of alloyed steel on high temperatures. The effect of temperature on fatigue behaviour is experimentally analyzed. The highest resistance to crack propagation, expressed by minimum fatigue crack growth rate, was exhibited in the specimens pre-cracking in parent metal and maximum fatigue crack growth rate is found in specimens pre-cracked in heat-affected –zone.

– *The effect of service temperature and life on the fatigue properties of high-alloyed steel* (Dž.Gačo- University of Bihać, Z.Burzić, VTI-Belgrade, M.Burzić, Institute GOŠA d.o.o Belgrade)

The effect of service temperature and life on high-cycle fatigue properties and fatigue crack growth rate of steel X20CrMoV 12-1 has been analyzed by testing the new steel and steel after service for 116000 hours. The investigations included fatigue strength and parameters of fatigue-crack growth rate at room and operating temperatures. These investigations and their analysis provide a practical contribution to assessment of behaviour of high alloy steel X20 under variable loading, thus ensuring safety in operation of the components in thermal power plants.

Conclusion

The Conference provided an outstanding opportunity for the participants to meet and discuss the recent advancements in *Computation methods in structural analysis and optimisation of the complex constructions*. During this Conference, new ideas and research results in many domains of structural design with respect to failure of materials and structures were presented. Practical and scientific contributions in the domains of analytic and computation methods in fracture mechanics analyses, improved mechanical properties with respect to fatigue lives, computation and test methods in fatigue life estimations were also presented.

Received: 15.04.2007.

Prvi srpski kongres teorijske i primenjene mehanike

Первый Международный конгресс в организации идружбы машиностроительных инженеров Сербии

Le premier congrès international de la Société de mécanique de Serbie