Practical Aspects of Finite Element Method Applications in Dentistry

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was born in 1970. He graduated from the Faculty of Mechanical Engineering, University of Belgrade in 1994. He passed final examination on Aircraft Structure Analysis subject. In year 2000 Aleksandar Grbovic received MSc. degree, while in June 2012 he received Ph.D. degree from the University of Belgrade. Title of his Ph.D. Thesis was: "Fatigue Life Investigation of Structural Components Made of Superalloys". In 2013 he received award of Belgrade Chamber of Commerce for the best Ph.D. thesis in previous year.

At the moment A. Grbovic is associate professor at the Department for Aeronautics, Faculty of Mechanical Engineering and visiting professor at School of Dental Medicine, University of Belgrade. His main research interests are fatigue design, design and analysis of aircraft structures and finiteelement analysis (FEA) of bio-mechanical structures, on which he has published more than 50 research papers. He was co-author of four papers about application of numerical methods in dentistry (namely “Analysis of load distribution in tooth-implant supported fixed partial dentures by the use of resilient abutment”, “Free-end saddle length influence on stress level in unilateral complex partial denture abutment teeth and retention elements”, “Stress Analysis Of A Unilateral Complex Partial Denture Using The Finite-element Method” and “Comparative Analysis of Unilateral Removable Partial Denture and Classical Removable Partial Denture by Using Finite Element Method”). Professor Grbovic was leader of the scientific project on the optimal design of mini dental implants sponsored by Serbian Ministry of Science in 2010.

He was co-author of three chapters in two books about the applications of FEA in dentistry and co-author of the chapter in the book “Recent Trends in Fatigue Design”, published by Nova Science Publishers in New York, 2015. He is co-author of the textbook “Software Tools in Design” (2016) published by the Faculty of Mechanical Engineering, Belgrade. Professor Grbovic attended more than 20 international conferences and was invited lecturer at few international conference on Fracture Mechanics. His h-index is 5.

Aleksandar Grbovic is a member of several international and domestic society.

Abstract

The use of numerical methods, such as finite element method (FEM), has been widely adopted in solving structural problems with complex geometry under external loads for which is not possible to achieve an analytical solution. Basic idea behind FEM is to divide the complex body geometry into smaller and simpler domains, called finite elements, and then to formulate solution for each element instead of seeking a solution for the entire domain. After finding the solutions for all elements they can be combined to obtain a solution for the whole domain. This numerical method is mostly used in engineering, but it’s also very useful for studying the biomechanical properties of materials used in medicine and the influence of mechanical forces on the biological systems. Since the FEM was
introduced in dentistry four decades ago, it became powerful tool for the predictions of stress and strain distribution on teeth, dentures, implants and surrounding bone. FEM can indicate aspects of biomaterials and human tissues that can hardly be measured in vivo and can predict the stress distribution in the contact areas which are not accessible, such as areas between the implant and cortical bone, denture and gingiva, or around the apex of the implant in trabecular bone. Aim of this paper is to present – using results of several successfully carried out FEM calculations – the usefulness of this method in solving dentistry problems, as well as to discuss practical aspects of FEM applications in dentistry. Some of the limitations of the method, such as impossibility of completely replicating clinical conditions and need for simplified assumptions regarding modeling of loads and materials, are also presented. However, the emphasis is on detailed FE modelling of teeth, gingiva, bone and implants (including the interfaces between them) and their fast modifications and changes as per the requirement. All studies presented here have been carried out in commercial software for finite element analysis ANSYS Workbench.