МЕХАНИКА/MECHANICS

FEM ANALYSIS IN DENTISTRY

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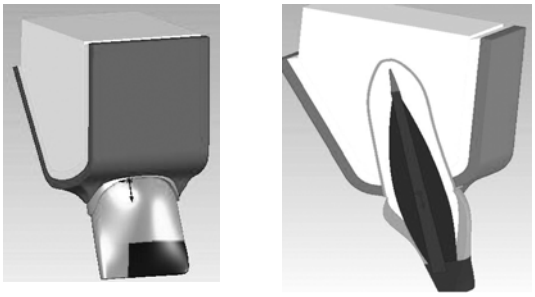
Finite element modelling (FEM) analysis is an important and useful instrument of quantitative analysis of the strain-stress state in dental implant research [1], root canal-post systems and restored weakened roots [2], shape optimization of the dental prosthetic design [3], orthodontic force distribution, heat distribution during and after the laser ablation, design and efficiency of head gears [4], 3d bone-implant interface [5], and many other important dental problems. An easy-to-use FEM software tools for the biomechanical analysis of the dental problems become more and more popular and advanced dentists can build and analyze them in real-time computations in their everyday practice.

Tooth restoration is one of the routine procedures and in some cases when simultaneous crown restoration and canal filling, the decision on necessity of artificial crown can be made on the FEM analysis of the whole system. In this case study a massive restoration of the crown of incisor together with a pin located in the canal of the tooth are analyzed at different restoration volume and the pin materials (carbon, glass or resin) (Fig.1). Influence of the stress-strain state of the restored tooth on the stresses in the bone and the root-bone interface is an important argument if decision making in the dental procedure. The FEM models have been designed in SolidWorks 2008 and then meshed in ANSYS Workbench Ver. 14.0. The models have been loaded by a physiological load. The Young's Modulus of the cement has been taken as 18600 and 7000 MPa.



a b

Fig.1. Incisor with a piece of filling (black region) in the frontal (a) and cross sectional (b) view.

Numerical results have been traced along two paths, first of which was a cervico-incisal one at the same mesio-distal dimension as the vertical wall of the cavity (Fig.2a) and the second path being defined by moving along the horizontal wall of the cavity (interface of the enamel and the restoration, Fig.2b) to reach the corner and then continuing in a vertical direction to reach the edge of incisor. Basing on the computation data, in order to decrease the stress in the enamel, it is suggested to use stronger pin and cement materials. The computed equivalent (von Mises) stress distributions along the two passes are presented in Fig.3.

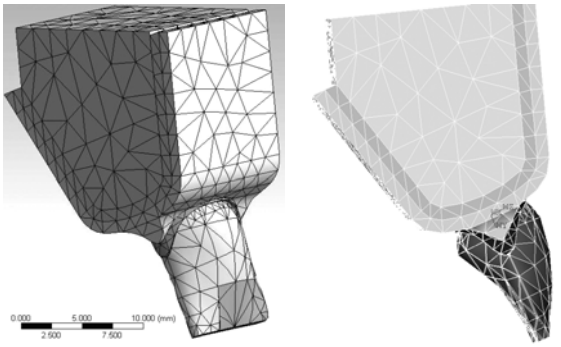


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Fig.2. Mesh generation for the studied system: 3D (a) and cross sectional (b) views.

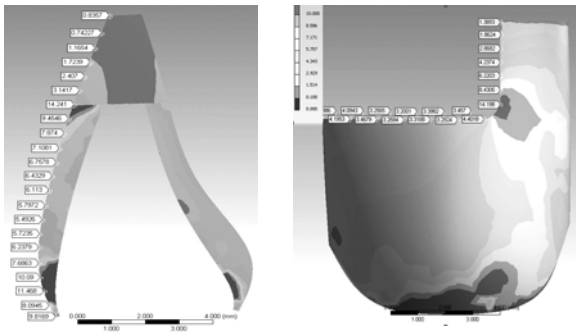

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Fig.3. Equivalent (von Mises) stress distributions along the cervico-incisal (a) and frontal (b) traces.

It was shown, the maximal stress concentration in the inner edge of the tooth, just at the interface tooth-filling, independently on the type of the filling material properties. In some cases the combination tooth+pin+filling is not stiff enough and additional procedure of artificial crown is necessary.

LITERATURE

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