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## Boundary integral equations for stress analysis of technical structures (from jet blades to tooth implants)

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For solution of stress concentration and fracture mechanics problems the direct boundary integral equation (BIE) method is used. For elasticity problem without body forces the direct BIE for homogeneous structure is given by [1]:

$$c_{ij}\left(p\right)u_i\left(p\right) = \int\limits_{\Gamma} \left[G_{ij}\left(q,p\right)t_i\left(q\right) - F_{ij}\left(q,p\right)u_i\left(q\right)\right]d\Gamma\left(q\right), \quad i,j = 1..m \tag{1}$$

where $c_{ij}\left(p\right)$ depends on the local geometry of the boundary $\Gamma$ (for a smooth boundary $c_{ij}\left(p\right) = 0.5\delta_{ij}$), $G_{ij}\left(q,p\right)$ and $F_{ij}\left(q,p\right)$ are fundamental solutions of the equilibrium equations for displacements and stresses, respectively, $t_i\left(q\right)$ and $u_i\left(q\right)$ are the boundary tractions and the boundary displacements on the structure surface and the location of source and field points belonging to the boundary are defined by the coordinates of points $q$ and $p$, $m = 2$ for two-dimensional and axisymmetric problems, $m = 3$ for three dimensional problems.

The multi-domain formulation of the BIE is applied for the composite structures modelling. The equations (1) are considered for each of homogeneous sub-region of the structure with the additional boundary conditions between sub-regions.

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The fundamental solutions in the equation (1) for an isotropic material are well-known [1]. When 3D problems with an arbitrary anisotropy are considered, only numerical methods can be used for representation of the fundamental solutions. For this purpose we use the method based on the multipole decomposition into the series of spherical harmonics [2].

The numerical procedure including the computation of the fundamental solutions for a body with an arbitrary elastic anisotropy was incorporated into the boundary element package for the analysis of 2D and 3D thermo-elastic multi-region problems with body forces [3, 4].

Plates with holes of different shapes and orientations are wide used in the modern technology. In the neighborhood of holes the stress state is often triaxial in nature and the problem should be considered as the three-dimensional one.

The computational analysis of the stresses concentration for some flat plates with oblique and conical holes under in-plane tensile and thermal loading for different angles of the obliquity was performed.

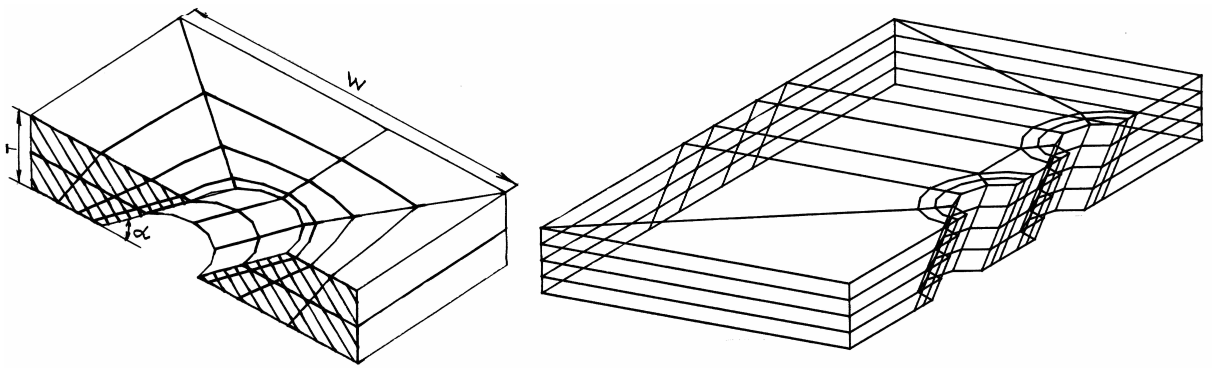


Fig. 1: Plates with one (left) and two oblique holes - models of turbine blades cooling system

Stresses concentration analysis in dental implants consists of the two stages:

1) analysis of the structure whole with smoothed screw in the junction between an implant and a bone;

2) analysis of the stresses concentration in the screwed junction at the contact boundary between the implant and bone.

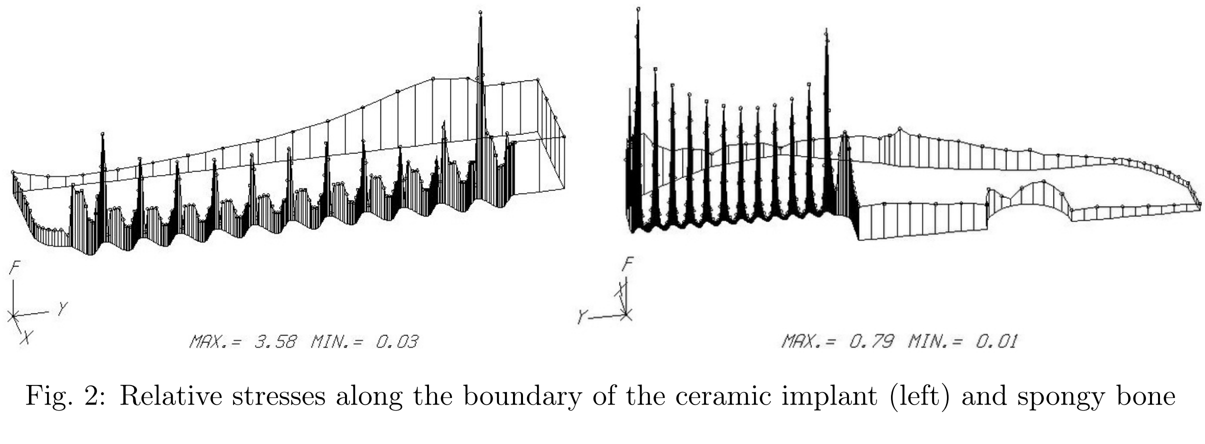


Fig. 2: Relative stresses along the boundary of the ceramic implant (left) and spongy bone

The computational model of the first stage contain of 7 sub-domains which are conforming to various parts of the implant. On all boundaries between sub-domains of the implant model were imposed the ideal contact conditions.

Analysis of the stresses concentration at the screw and bone junction was performed at the second stage of the research. It was assumed, that hollows in the spongy bone, formed in a bone after an implant penetration, are conformed to the screw thread on the implant. The following parameters of models were investigated: mechanical properties of implants and surrounding bones; shape of screw thread; the quality of junction conditions between implants and bones - from full sliding to full osseointegration. In the latter case the boundary between the implant screw thread and the bone was considered on the basis of weak interface model.

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# An Example of a None-zero Walsh Series with Riesz-spaces' Coefficients and Vanishing Partial Sums $S_{2^k}$

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A none-zero Walsh series with coefficients from a Riesz-space and partial sums $S_{2^k}$ $(o)$ - converging to 0 is presented.

In this work we consider an example of a Walsh series [1] with coefficients belonging to a Riesz-space [2]. The partial sums $S_{2^k}$ of this series $(o)$ - converge to the element 0 of the Riesz-space [3, 4]. Nevertheless, the series is not the null series. Thus, we can not recover coefficients of the series using $(o)$ - convergence. It is an additional argument for introduction of $(u)$ - convergence (see [4]). There are some results of using it in [4, 5].

**Theorem 1.** There exist a series in the Walsh system with coefficients belonging to a Riesz-space $R$ such that it $(o)$ - converges to $0 \in R$ with respect to the subsequence of the natural numbers $n_k = 2^k,\ k = 0, 1, \dots$ but this series is not a null series.

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