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DYNAMIC SKEW-SYMMETRIC PROBLEM OF COUPLED THERMOELASTICITY FOR A LAYER CONTAINING A HOLE

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We consider a problem of coupled thermoelasticity for a layer weakened by a through hole and construct its homogeneous and F-solutions. By using these solutions, the boundary-value problem is reduced to a system of singular integral equations of the second kind. The dependence of the dynamical concentration of relative circular stresses on the first relative wave number is analyzed. The effect of coupling of the thermomechanical fields is demonstrated.

In recent years, the problems of nonlinear and coupled thermoelasticity are studied more and more extensively. This is connected with the development of technologies of investigation of the microstructure of deformed bodies. Due to the violation of the integrity of materials under the conditions of strong deformation and heating, the description of these processes within the framework of classical continuum mechanics encounters serious difficulties. The practical necessity of the numerical analyses of coupled fields in thermoelastic materials that can be used in various devices equipped with the mechanisms of energy dissipation (magnetic anisometers, micro- and nanoelectromechanical oscillators, etc.) is emphasized in [1].

In the investigation of massive structures, the approach based on the three-dimensional theory of elasticity proves to be most general and exact. At present, there are practically no results of the solution of three-dimensional equations of the coupled problem of thermoelasticity for massive bodies. This is explained by the complexity of the solution of equations in displacements or stresses. In fact, we know only the solutions of some problems for thin-walled plates and shells, half spaces with holes, etc. [2–8]. Therefore, the development of the analytic and numerical procedures aimed at the solution of three-dimensional problems of coupled thermoelasticity is an actual problem of the mechanics of deformable bodies.

As one of the efficient methods used to solve the problems of mathematical physics, we can mention the method of homogeneous solutions extensively applied to various problems of heat conduction and thermo- and electroelasticity. Parallel with this method, a new approach (proposed by one of the authors and called the F-solutions [9]) is now often used to solve boundary-value problems. According to this approach based on the F-solutions for a layer, i.e., on specific Green functions corresponding to the distribution of concentrated forces along a segment parallel to the x_3-axis, the three-dimensional problems of the theory of elasticity can be solved for multiply connected plates and cylindrical shells and the analyzed problem is reduced to well-studied one-dimensional integral equations. In what follows, the scheme of application of the F-solutions is extended to the generalized coupled problem of thermoelasticity for a layer weakened by a through hole.

Homogeneous Solutions

As a result of the exclusion of the time factor $e^{-i\omega t}$, the basic system of equations of coupled thermoelasticity [5, 7, 8] takes the form

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