Hidden defects in covers of materials, faults in seismology and prevention of hazards

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Abstract

The connection between the behavior of covered materials with defects such as cracks perpendicular to the boundaries of elastic bodies and lithospheric plates with faults in case of various external influences in layered bodies is explained. Such behavior of these mechanical structures is seen during different types of external influences. The block element method is applied, which allows to investigate arising boundary problems difficult to study with other approaches. The stress-strain state of block structures generated by the studied mechanical problems was investigated, and the conditions of stress concentration build-up in hazardous areas were found. It was established that there are parameters, the role of which is paramount in assessing the possibility of destruction of the structures under consideration. The conditions allowing to exclude the occurrence of damage because of defects and faults, or to reduce the level of destruction were formulated for a number of problems.

Keywords: packed block element, factorization, topology, integral and differential factorization methods, exterior forms, block structures, boundary problems, stress-strain state, deformable blocks, Kirchhoff plates, differential and integral equations

1 Introduction

The theory of blocked structures, designed in the South Research Center of RAS, has several various advantages discussed right below. It allows solvation of boundary value problems for the system of differential equations in particular derivatives in some systems in analytical form. The basis of this theory is differential method of factorization. This method has been overlooked by scientists involved in the development of factorizing approaches for a long time. The reason is that the method required involvement of modern mathematical methods. Being highly precise though still rather complex in application, the method was applied in various other areas. In the report there is an example of application of the method in the task of solidity of bodies with plating. The possibility of an initial earthquake and the seismic rating in a restricted fault zone are being explored in this work with application of the method of block elements. Approximate integral equations are constructed for the cases of finite and semi-infinite faults, and the symbol structure of the kernel of integral equation is derived. The latter may be used not only for analyzing the singular features in boundary values, but also for studying wave processed in faults in dynamic tasks.

2 Stating The Aim

The starting data on initial earthquakes, research methods and the results are published in [1, 2, 3]. Let us consider the covering on the malformed base to represent Kirchoff's plate with three types of defects: infinite defect, which divides the plate into two semi-infinite plates; semi-infinite, when the defect is a semi-infinite fracture; and finite, when the defect is a finite fracture. Let us consider that, from a certain point, the edges of all three types of defects with parallel borders are remote from each other for 2θ and are on a linearly deformable base. Let us consider that the space between the edges of the defect is empty, and the butt ends of the plates are affected by outer forces directed according to the rule of external vectors. In the $x_1x_2x_3$ system of coordinates with the onset in the x_1x_2 plane, which is congruent with the median plane of the plate. the axis ox_3 directed up the normal to the plate, the axis ox_1 directed tangentially towards the border of the defect, the axis ox_2 – normally to the border. The area of the plate positioned to the left from the defect is marked λ and is described by the correlations $|x_1| \leq \infty$, $x_2 \leq -\theta$, and the one to the right – by the index r and coordinates $|x_1| \leq \infty$, $\theta \leq x_2$. Let us limit ourselves to the vertical influences on the plates only, considering that bending moments and shear forces different from zero can be assigned to the butt ends. Kirchoff's equation for the b fragments of the $b = \lambda, r$ covering which are situated in Ω_b areas with $\partial\Omega_b$ borders takes the following form with the determined vertical static influences with tension, t_{3b} up and g_{3b} down:

$$\mathbf{R}_b(\partial x_1, \partial x_2)u_{3b} + \varepsilon_{53b}(t_{3b} - g_{3b}) \equiv$$
$$\equiv \left(\frac{\partial^4}{\partial x_1^4} + 2\frac{\partial^2}{\partial x_1^2}\frac{\partial^2}{\partial x_2^2} + \frac{\partial^4}{\partial x_2^4}\right)u_{3b} + \varepsilon_{53b}(t_{3b} - g_{3b}) = 0 \quad (1)$$

$$\mathbf{R}_b(-i\alpha_1, -i\alpha_2)U_{3b} \equiv R_b(-i\alpha_1, -i\alpha_2)U_{3b} \equiv (\alpha_1^2 + \alpha_2^2)^2 U_{3b}$$

$$U_{3b} = \mathbf{F_2}u_{3b}, \quad G_{3b} = \mathbf{F_2}g_{3b}, \quad T_{3b} = \mathbf{F_2}t_{3b} \quad b = \lambda, r$$

$$M_b = -D_{b1}\left(\frac{\partial^2 u_{3b}}{\partial x_2^2} + \nu_b \frac{\partial^2 u_{3b}}{\partial x_1^2}\right), \quad D_{b1} = \frac{D_b}{2}, \quad D_{b2} = \frac{D_b}{3}$$

$$Q_b = -D_{b2}\left(\frac{\partial^3 u_{3b}}{\partial x_2^3} + (2 - \nu_b)\frac{\partial^3 u_{3b}}{\partial x_1^2 \partial x_2}\right) = f_{4b}(\partial\Omega_b)$$

$$u_{3b} = f_{1b}(\partial\Omega_b), \quad \frac{\partial u_{3b}}{\partial x_2} = f_{2b}(\partial\Omega_b)$$

$$D_b = \frac{E_b h_b^3}{12(1-\nu_b^2)}, \quad \varepsilon_{53b} = \frac{(1-\nu_b^2)12^4}{E_b h_b^3}, \quad \varepsilon_6^{-1} = \frac{(1-\nu)H}{\mu}$$

The connection between edge tensions and shifting on the surface of the elastic medium on which the plates are situated, takes the following form:

$$u_{3m}(x_1,x_2) = \varepsilon_6^{-1} \sum_{n=1}^{2} \iint_{\Omega_n} k(x_1-\xi_1, x_2-\xi_2) g_{3n}(\xi_1,\xi_2) d\xi_1 d\xi_2,$$

$$x_1, x_2 \in \Omega_m, \quad m = \lambda, r, \theta,$$

$$\Omega_\lambda(|x_1| \le \infty;\ x_2 \le -\theta), \quad \Omega_r(|x_1| \le \infty;\ \theta \le x_2),$$

$$\Omega_\theta(|x_1| \le \infty;\ -\theta \le x_2 \le \theta), \quad n = \lambda, r$$

$$k(x_1,x_2) = \frac{1}{4\pi^2} \int_{-\infty}^{\infty}\int K(\alpha_1,\alpha_2) e^{-i\langle\alpha,x\rangle} d\alpha_1 d\alpha_2$$

$$u_{3m}(x_1,x_2) = \frac{1}{\varepsilon_6 4\pi^2} \int_{-\infty}^{\infty}\int K(\alpha_1, \alpha_2 G(\alpha_1,\alpha_2) e^{-i\langle\alpha,x\rangle} d\alpha_1 d\alpha_2$$

$K(\alpha_1, \alpha_2)$ is the analytical function of two complex variables α_k, particularly meromorphic, its various examples are presented in [4, 5], M_b and Q_b – bending moment and shear force in the $x_1 o x_2$ system of coordinates; h_b – thickness of the plates, H – dimensional parameter of substructure, for instance, the thickness of the layer. E_b – Young's moduli of the plates, ν_b – their Poisson ratios. The nomenclature is taken from [1], $\mathbf{F}_2 \equiv \mathbf{F}_2(\alpha_1,\alpha_2)$ and $\mathbf{F}_1 \equiv \mathbf{F}_1(\alpha_1)$, two- and one-dimensional Fourier-transform operators respectively.

3 The factorization method for block element

Above-mentioned academicians examine packed block elements in the blocked structure derived from a boundary-value problem for systems of linear differential equations in partial derivatives as topological objects. It is proved that they can be regarded as a manifold with brink edge in certain spaces representing the Cartesian product of topological spaces. This makes it possible to carry out the interference of packed block elements for block structure construction of varying degrees of complexity. The latter can be achieved by choosing the block elements with different properties and then can be obtained obtained the desired properties of the block structure. In the work [6] the notion of packed block elements was added. Packed block element – is locally represented accurate solution of a boundary-value problem in the chosen carrier. It derives from a regularized element of algebraic rings on ideal [7]. A regularization is being carried out by solving the pseudo-differential equations which being stated by external forms generated by boundary-value problem. With the aim of distancing from the "exterior algebra" which let to set up the external forms and which doesn‘t contribute to the transformations used in the regularization process in the block element theory which is called "external analysis" [8]. A block element can be called packed in case if the caused by regularization pseudodifferential equations can be solved for it. Homeomorphisms in theory block elements are very effective and necessary as they allow by performing a constructional design in well-studied spaces from R^n to transfer them to a more complex structure.

Without an attempt to embrace a huge variety of boundary problems and geometric forms of packaged block elements carriers, let analyze the case of block elements obtained at the intersection of three-dimensional layer and an infinite prism which have a polygon in its intersection and which axis is perpendicular to the boundary layer. Let us approve that their conjunction can be built by two diverse neighboring packed blocks which have a common bound and in such a manner you can obtain a new packed block element which is ready to conjugate with adjacent element. After that this algorithm can be relatively easy applied to more difficult boundary problems and block elements. Let us denote one of the block elements$b$, its carrier – Ω_b and the second – d with carrier Ω_d. Flat contact borders of two block elements are signed as $\partial\Omega_{bd}$ for the side belonging to the block element b, $\partial\Omega_{db}$ – belonging to the element d and we consider that borders coincide on contact. Let us look firstly at a boundary problem of one linear partial differential equation in order $2r$ with boundary conditions of associated solutions, which include equality not only on the borders of solutions but also combinations of their derivate, on standards as well as on a tangent border, with the order of leading derivate r. Obviously, the borders are perpendicular to the stratum boundaries. Let us bring here Cartesian coordinate system $ox^1x^2x^3$, pointing the axis ox^3 perpendicular to the stratum boundary, axis ox^1 – perpendicular to the boundaries $\partial\Omega_{bd}$, $\partial\Omega_{db}$, and apply the right triple rule to the last axis. Let us denote as local solutions for the already discussed boundary problem for every block element in accordance. Added Cartesian coordinate system inducts in Euclidean space topology [9, 10, 11, 12]. Let us call open multitudes of block elements carriers opened spheres, which consist of inner points, and also sphere segments divided from the opened sphere with the border, which belongs to the block element. Every union of such opened spheres stays opened. Let us denote $P_b\left(x_b^1, x_b^2, x_b^3\right)$ and $P_d\left(x_d^1, x_d^2, x_d^3\right)$ as topological fields points of $\Omega_b\left(x_b^1, x_b^2, x_b^3\right)$ and $\Omega_d\left(x_d^1, x_d^2, x_d^3\right)$ carriers.

Thus, it is proved, packed block elements under coupling produce a packed block element with carrier, which unified initial ones. If initial block elements were single card manifolds, then a new block element is a manifold with double card atlas. This result increases opportunities of using of block elements for constructing of complex block constructions for different use.

In the another area of border of $\partial\Omega_{bdp}$ newly formed packed block elements $\Omega_{bd} = \Omega_b \cup \Omega_d$ there can be contact with another packed block element Ω_p. As above, borders have to be considered $\partial\Omega_{dbp}$ and $\partial\Omega_{pdb}$, further statements are analogous to given above ones. For the record, border conditions on the new border can differentiate from reviewed ones early it means, a boundary problem is set with mixed border conditions. This circumstance does not change stated constructions, as the problem of construction of packed block elements with mixed border conditions refers to the solution of pseudodifferential equations, which are supposed completed.

In the case of vectorial border problems, set in areas Ω_b and Ω_d, which are described by the system of differential equations in partial derivatives, solutions of which have several components. First of all, each component of concerned border problems in the form of pack block element is formed by differential and integrated factorization methods with the using of function matrix factorization (external analysis [8]). Border conditions will be complicated by including a combination of different elements and variables. At that time, it is easy to understand, the topological characteristics of all components and variables remain and homeomorphisms of topological space carriers are under way. In the case, if packed block elements have carries with complicated shapes, multi-card atlas, then for the formation of homeomorphisms in the including topologies with the substitutions of variables areas can be demanded.

Thus, packed block elements allow forming block constructions, which in turn become packed block elements, which presenting the solution of border problem in the area of its carriers.

Considering the plates and base to be a block structure consisting of three deformable blocks, the block element method can be used to study it. This method, as described in [8], includes, as a first step, the immersion in the topological structure by means of exterior algebra of boundary value. The authors call the multistage algorithm of further research of the functional equation that have nothing to do with the means of exterior algebra peer evaluation in the block element theory [8]. It includes fluxional factorization of matrix functions with elements of several composite variables, the realization of automorphism consisting either of calculation of residue forms of Leray, or incomplete functional equations of Wiener-Hopf, building up of pseudodifferential equations, extraction from them integral equations, dictating by concrete boundary conditions of boundary value problem, solving integral equations and integral expression of the boundary value problem in every block in the form of the "packed" block element. Finally, "gluing together" solutions of every block, consisting of building of factor – the topology of some topological spaces, which are Cartesian products of topological spaces of carriers and solutions. Using the descriptive approach, the functional equation of the boundary value problem (1) has the following form

$$R_b(-i\alpha_1,-i\alpha_2)U_{3b} \equiv (\alpha_1^2+\alpha_2^2)^2 U_{3b} = -\int\limits_{\partial\Omega_b} \omega_b - \varepsilon_{53b} S_{3b}(\alpha_1,\alpha_2) \tag{2}$$

$$S_{3b}(\alpha_1,\alpha_2) = \mathbf{F}_2(\alpha_1,\alpha_2)(t_{3b}-g_{3b}), \quad b=\lambda, r$$

Here – participating in introduction exterior forms [1, 2, 3], which have, taking into account a choice of the coordinate system, the following view

$$\omega_b = e^{i\langle\alpha,x\rangle}\left\{-\left[\frac{\partial^3 u_{3b}}{\partial x_2^3} - i\alpha_2\frac{\partial^2 u_{3b}}{\partial x_2^2} - \alpha_2^2\frac{\partial u_{3b}}{\partial x_2} + i\alpha_2^3 u_{3b} + 2\frac{\partial^3 u_{3b}}{\partial x_1^2\partial x_2} - 2i\alpha_2\frac{\partial^2 u_{3b}}{\partial x_1^2}\right]dx_1 + \right.$$
$$\left. + \left[\frac{\partial^3 u_{3b}}{\partial x_1^3} - i\alpha_1\frac{\partial^2 u_{3b}}{\partial x_1^2} - \alpha_1^2\frac{\partial u_{3b}}{\partial x_1} + i\alpha_1^3 u_{3b}\right]dx_2\right\}, \quad b=\lambda, r$$

and in a special case of straight-line boundary there can be introduced by the following formulae

$$\omega_\lambda = e^{i\langle\alpha,x\rangle}\Bigg\{-\Bigg[i\alpha_2 M_\lambda D_\lambda^{-1} - Q_\lambda D_\lambda^{-1} - (\alpha_2^2+\nu_\lambda\alpha_1^2)\frac{\partial u_{3\lambda}}{\partial x_2}+ \\ + i\alpha_2\left[\alpha_2^2+(2-\nu_\lambda)\alpha_1^2\right]u_{3\lambda}\Bigg]\Bigg\}dx_1$$

$$\omega_r = -e^{i\langle\alpha,x\rangle}\Bigg\{-\Bigg[i\alpha_2 M_r D_r^{-1} - Q_r D_r^{-1} - (\alpha_2^2+\nu_r\alpha_1^2)\frac{\partial u_{3r}}{\partial x_2}+ \\ + i\alpha_2\left[\alpha_2^2+(2-\nu_r)\alpha_1^2\right]u_{3r}\Bigg]\Bigg\}dx_1 \quad (3)$$

In the formulas (2), (3) at the time of integration the boundary $\partial\Omega_b$ is represented by two butt-ends of right and left Kirchhoff plates, if defect is infinite and divides plates in half. As the area occupied with covering is treated as topological manifold with boundary, so local coordinates are set on the boundary, the orientation of which is coordinated with the orientation of the interior of manifold. If defect is semi-infinite or finite, the crack edges will be boundaries with the corresponding orientation. For implementation of the automorphism, calculated the residue forms of Leray [1, 2, 3], according to the parameter α_2, also in twofold poles, pseudodifferential equations of boundary value problem, taking into consideration agreed notations, we can represent in the following form

$$\mathbf{F}_1^{-1}(\xi_1^\lambda)\Bigg\langle-\int\limits_{\partial\Omega_\lambda}\Bigg\{i\alpha_{2-}D_{\lambda1}^{-1}M_\lambda - D_{\lambda2}^{-1}Q_\lambda - (\alpha_{2-}^2+\nu_\lambda\alpha_1^2)\frac{\partial u_{3\lambda}}{\partial x_2}+ \\ + i\alpha_{2-}\left[\alpha_{2-}^2+(2-\nu_\lambda)\alpha_1^2\right]u_{3\lambda}\Bigg\}e^{i\alpha_1x_1}dx_1 + \varepsilon_{53\lambda}S_{3\lambda}(\alpha_1,\alpha_{2-})\Bigg\rangle = 0$$

$$\alpha_{2-} = -i\sqrt{\alpha_1^2}, \quad \xi_1^\lambda \in \partial\Omega_\lambda$$

$$\mathbf{F}_1^{-1}(\xi_1^\lambda)\Bigg\langle-\int\limits_{\partial\Omega_\lambda}\Bigg\{iD_{\lambda1}^{-1}M_\lambda - 2\alpha_{2-}\frac{\partial u_{3\lambda}}{\partial x_2} + i\,[\,3\alpha_{2-}^2+(2-\nu_\lambda)\alpha_1^2\,]\,u_{3\lambda}\Bigg\}e^{i\alpha_1x_1}dx_1+ \\ + \varepsilon_{53\lambda}S'_{3\lambda}(\alpha_1,\alpha_{2-})\Bigg\rangle = 0$$

$$\xi_1^\lambda \in \partial\Omega_\lambda, \quad \partial\Omega_\lambda = \{-\infty \le x_1 \le \infty,\ x_2 = -\theta\}$$

The derivative is calculated according to the parameter α_2.
Using further on this method, we come to the system of functional equations of this sort

$$\left[\varepsilon_{53r}(\alpha_1^2+\alpha_2^2)^{-2}+\varepsilon_6^{-1}K_1(\alpha_1,\alpha_2)\right]G^+(\alpha_1,\alpha_2) = \\ = -\left[\varepsilon_{53\lambda}(\alpha_1^2+\alpha_2^2)^{-2}+\varepsilon_6^{-1}K_1(\alpha_1,\alpha_2)\right]G^-(\alpha_1,\alpha_2) + U_{3\theta}(\alpha_1,\alpha_2)+ \\ + (\alpha_1^2+\alpha_2^2)^{-2}[A_\lambda k_{1\lambda0}+B_\lambda k_{2\lambda0}+A_r k_{1r0}+B_r k_{2r0}+ \\ + \varepsilon_{53\lambda}T^+(\alpha_1,\alpha_2)+\varepsilon_{53r}T^-(\alpha_1,\alpha_2)], \quad \theta>0$$

$$U_{3\theta}(\alpha_1,\alpha_2)=\int\limits_{-\infty}^{\infty}\int\limits_{-\theta}^{\theta}u_3(x_1,x_2)e^{i\langle\alpha,x\rangle}dx_1dx_2$$

$$\begin{aligned}&\left[\varepsilon_{53r}(\alpha_1^2+\alpha_2^2)^{-2}+\varepsilon_6^{-1}K_1(\alpha_1,\alpha_2)\right]G^+(\alpha_1,\alpha_2)=\\&=-\left[\varepsilon_{53\lambda}(\alpha_1^2+\alpha_2^2)^{-2}+\varepsilon_6^{-1}K_1(\alpha_1,\alpha_2)\right]G^-(\alpha_1,\alpha_2)+\\&+(\alpha_1^2+\alpha_2^2)^{-2}[A_\lambda k_{1\lambda 0}+B_\lambda k_{2\lambda 0}+A_r k_{1r0}+B_r k_{2r0}+\\&\qquad\qquad+\varepsilon_{53\lambda}T^+(\alpha_1,\alpha_2)+\varepsilon_{53r}T^-(\alpha_1,\alpha_2)],\quad \theta=0\end{aligned}$$

Here A_λ, B_λ, A_r, B_r – are the expressions of the composite species, for the sake of brevity, are omitted. It should be noticed, that the represented functional equations have as unknown variables not only functions $G^+(\alpha_1,\alpha_2)$, $G^-(\alpha_1,\alpha_2)$, but also the functionals $G^+(\alpha_1,\alpha_{2+})$, $G^-(\alpha_1,\alpha_{2-})$, $G^+(\alpha_1,\alpha_{2+})$, $G^{-\prime}(\alpha_1,\alpha_{2-})$, which enter linear $k_{1\lambda 0}$, $k_{2\lambda 0}$, k_{1r0}, k_{2r0} and which are in need of determination. We have obtained two different Wiener-Hopf's functional equations. The first one is the generalized Wiener-Hopf's functional equation, because of the presence of the function $U_{3\theta}(\alpha_1,\alpha_2)$. It can be solved as stated in [5], by the conversion of a system of two integral equations of the second kind with quite continuous functions in a certain space with weight, which has the form

$$X^+-\left\{-\frac{M_1^+}{M_2^-}Y^-e^{-i2\alpha_2\theta}\right\}^+=\left\{\frac{1}{M_2^-}\Phi e^{-i\alpha_2\theta}\right\}^+$$

$$Y^-+\left\{\frac{M_2^-}{M_1^+}X^+e^{i2\alpha_2\theta}\right\}^-=\left\{\frac{1}{M_1^+}\Phi e^{i\alpha_2\theta}\right\}^-$$

$$M_1=M_1^+M_1^-,\quad M_2=M_2^+M_2^-,$$

$$M_2^+G^+=X^+,\quad M_1^-G^-=Y^-$$

$$M_1=\left[\varepsilon_{53\lambda}(\alpha_1^2+\alpha_2^2)^{-2}+\varepsilon_6^{-1}K(\alpha_1,\alpha_2)\right]$$

$$M_2=\left[\varepsilon_{53r}(\alpha_1^2+\alpha_2^2)^{-2}+\varepsilon_6^{-1}K(\alpha_1,\alpha_2)\right]$$

Here the designations of the work [5] are accepted.

Having solved boundary problems and defined functions $G^+(\alpha_1,\alpha_2)$, $G^-(\alpha_1,\alpha_2)$ it is also required to find the values of the functionals $G^+(\alpha_1,\alpha_{2+})$ and $G^-(\alpha_1,\alpha_{2-})$, and also the functionals which are differentiated according to the second parameter of the form $G_+'(\alpha_1,\alpha_{2+})$, $G_-'(\alpha_1,\alpha_{2-})$. To find them, we use the fact that, the solutions that are constructed in this way have the following structure.

$$\begin{aligned}G_+(\alpha_1,\alpha_2)&=C_{1+}(\alpha_1,\alpha_2)G_+(\alpha_1,\alpha_{2+})+C_{2+}(\alpha_1,\alpha_2)G_-(\alpha_1,\alpha_{2-})+\\&+C_{3+}(\alpha_1,\alpha_2)G_+'(\alpha_1,\alpha_{2+})+C_{4+}(\alpha_1,\alpha_2)G_-'(\alpha_1,\alpha_{2-})+C_{5+}(\alpha_1,\alpha_2)\end{aligned}$$

$$\begin{aligned}G_-(\alpha_1,\alpha_2)&=C_{1-}(\alpha_1,\alpha_2)G_+(\alpha_1,\alpha_{2+})+C_{2-}(\alpha_1,\alpha_2)G_-(\alpha_1,\alpha_{2-})+\\&+C_{1-}(\alpha_1,\alpha_2)G_+'(\alpha_1,\alpha_{2+})+C_{2-}(\alpha_1,\alpha_2)G_-'(\alpha_1,\alpha_{2-})+C_{3-}(\alpha_1,\alpha_2)\end{aligned}$$

We differentiate the first and the second equations by means of.
Here functions $C_{n+}(\alpha_1, \alpha_2)$, $C_{n-}(\alpha_1, \alpha_2)$, $n = 1, 2, 3$ are known, they can be easy found from the given above expressions, and $G_+(\alpha_1, \alpha_{2-})$, $G_-(\alpha_1, \alpha_{2+})$, $G'_+(\alpha_1, \alpha_{2+})$, $G'_-(\alpha_1, \alpha_{2-})$, is required to be determined. For their determination, we put $\alpha_2 = \alpha_{2+}$ in the first equation and in the differentiated one, but $\alpha_2 = \alpha_{2-}$ in the second one and the differentiated equation. So we obtain an algebraic system for the determination of all the above unknowns, we find the required functions by solving it. The introduction of the found solutions into the relations with external forms, depending on the stated boundary problem, makes it possible to determine completely the stress-strain state of the covering with or without any defects which are under review.
The second functional equation is the Wiener-Hopf's equation. The methods of constructing its exact or approximate solutions can be found in [4, 5]. It is easy enough to prove that the solution of the first functional equation for leads to the following properties of contact stresses between the plates and a substrate at the edges

$$g_{3\lambda}(x_1, x_2) = \sigma_{1\lambda}(x_1, x_2)(-x_2 - \theta)^{-1/2}, \quad x_2 < -\theta$$

$$g_{3r}(x_1, x_2) = \sigma_{1r}(x_1, x_2)(x_2 - \theta)^{-1/2}, \quad x_2 > \theta$$

Here $\sigma_{1b}(x_1, x_2)$, $b = \lambda, r$ are the continuous on the both coordinates functions for sufficiently smooth t_{3b}, $b = \lambda, r$ [4, 5]. The conversion of the second equation $x_2 \to 0$ leads to the following properties of the solutions

$$g_{3\lambda}(x_1, x_2) \to \sigma_{2\lambda}(x_1, x_2)x_2^{-1}$$

$$g_{3r}(x_1, x_2) \to \sigma_{2r}(x_1, x_2)x_2^{-1}$$

Functions $\sigma_{nb}(x_1, x_2)$, $b = \lambda, r$; $n = 2, 3$ are continuous according to the both parameters.

4 Semi-limited and limited faults or defects

While further studying the main research result of the study has established: infinite and semi-infinite defects always have singular stress concentrations at the edges of the plates while approaching the defects banks which bearing the danger of destroying the coated structure. The degree of structure destruction decreases as the size reduces of the defect of the finite length. The destruction degree is determined by the combinations of some parameters. The latter is established by investigating the coefficients in the case of the characteristic features. The following approximate formulas for the solving the boundary value problem are taken place, which are represented structurally without specifying all the parameters in connection with the complexity, which allows one to estimate the possibility of solving integral equations

$$K_0(\alpha_1) = -D\left(1 + \frac{B_\lambda L_-(\alpha_{2\lambda-}) + B_r L_+(\alpha_{2r+})}{\left[(B_r L_+(\alpha_{2r+}) + B_\lambda L_-(\alpha_{2\lambda-})) - \varepsilon_6^{-1} k_\infty(\alpha_1)\right]}\right)$$

$$D = -A_\lambda Q_\lambda(\alpha_1, -\theta) + A_r Q_r(\alpha_1, \theta), \quad \theta \geq 0$$

$$G_-(\alpha_1, \alpha_2) = L_-(\alpha_2)\frac{1}{\varepsilon_6^{-1} k_\infty(\alpha_1)} K_0(\alpha_1, \alpha_2)$$

$$G_+(\alpha_1, \alpha_2) = L_+(\alpha_2)\frac{1}{\varepsilon_6^{-1} k_\infty(\alpha_1)} K_0(\alpha_1, \alpha_2)$$

$$A_\lambda(\alpha_1, \alpha_2) = -\frac{e^{-i\alpha_2\theta}}{\alpha_{2\lambda-}}, \quad B_\lambda(\alpha_1, \alpha_2) = \frac{e^{-i(\alpha_2 - \alpha_{2\lambda-})\theta}}{\alpha_{2\lambda-}}$$

$$A_r(\alpha_1, \alpha_2) = -\frac{e^{i\alpha_2\theta}}{\alpha_{2r+}}, \quad B_r(\alpha_1, \alpha_2) = \frac{e^{i(\alpha_2 - \alpha_{2r+})\theta}}{\alpha_{2r+}}$$

In the case of the faults limited by the length, the integral equation for the determination of the behavior of the shearing forces approximately has the form in the case of the plates with different properties

$$\int_{-\infty}^{\infty} k(y-\xi)s(\xi)d\xi = \sigma_2(y), \quad -\infty \leq y \leq \infty$$

$$\frac{1}{\varepsilon_6^{-1} k_\infty(\alpha_1)} K_0(\alpha_1) = K(\alpha_1), \quad k(x_1) = \mathbf{F}_1^{-1}(x_1)K(\alpha_1)$$

$$D(\alpha_1) = -A_\lambda Q_\lambda(\alpha_1, 0) + A_r Q_r(\alpha_1, 0), \quad s(x_1) = \mathbf{F}_1^{-1}(x_1)D(\alpha_1)$$

In the case of the equality of the properties of the left and the right half-plates, that is

$$k_\infty(\alpha_1) = \lim |\alpha_2|^{-1} K(\alpha_1, \alpha_2), \quad |\alpha_2| \to \infty$$

Then

$$D = \frac{1}{\alpha_{2\lambda-}(\alpha_1)} \left[Q_\lambda(\alpha_1, 0) + Q_r(\alpha_1,)\right]$$

$$s_0(x_1) = \mathbf{F}_1^{-1}(x_1) \left[Q_\lambda(\alpha_1, 0) + Q_r(\alpha_1,)\right] \quad c_1 \leq x_1 \leq c_2$$

$$\int_{c_1}^{c_2} k_1(y-\xi)s_0(\xi)d\xi = \sigma_2(y), \quad c_1 \leq y \leq c_2, \quad k_1(x_1) = \mathbf{F}_1^{-1}(x_1)\frac{K(\alpha_1)}{\alpha_{2\lambda-}(\alpha_1)}$$

In that case, if $c_2 = \infty$ then an integral equation for a semi-infinite fault is obtained.

$$\int_{c_1}^{\infty} k_1(y-\xi)s_0(\xi)d\xi = \sigma_2(y), \quad c_1 \leq y \leq \infty$$

By means of these integral equations it is possible to determine the degree of the impact on the bank of the fault in order to reduce or increase the coefficient of the singular term in the contact stresses.

5 CONCLUSION

In such a manner, it's shown that block structures of elastic materials are under-explored elastic objects which have incalculable properties. Among them there are singular particularities in contact voltage for approached lithosphere plates. The integral equation is built which describes behavior of the function being the index of singular particularity. This equation allows getting in boundary problem parameter points which reduce or increase the rate of the index under particularity.

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