PERIODIC AND DOUBLY PERIODIC PROBLEMS
FOR PIECEWISE SPACE WITH DEFECTS

Hakobyan V.N.
Institute of Mechanics, National Academy of Sciences

Since the 1960s and 1970s, a large body of research has been conducted on the study of periodic and doubly periodic problems for homogeneous massive bodies with defects. The discontinuous solutions of equations of the elasticity theory for antiplane and plane problems for elastic spaces and planes with defects have been built through the analysis of periodic functions and powerful apparatus of Kolosov-Muskhelishvili complex potentials. On basis of solutions the governing equations of numerous periodic and doubly periodic problems and their closed or effective solutions are obtained. Many of results obtained in this regard are summarized in monographs [1-3]. On the basis of these results the theory of regularly reinforced composites has been proposed [3].

As far as similar problems for piecewise homogeneous, layered bodies are concerned, which are currently actual in relation to the study of layered composites, as we know, we have considered them for the first time in papers [4,5].

This paper considers the antiplane and plane stress states of piecewise homogeneous space, formed by alternate joining of two heterogeneous layers with same thickness with interphase periodic or doubly periodic tunnel defects on junction planes are considered.
First, in Cartesian system of coordinates the antiplane stress state for piecewise space, formed by alternate junction of two heterogeneous layers with thickness of with periodic system of tunnel parallel interphase defects on junction planes along stripes is considered. The line consists of finite number of disjoint intervals. It is assumed that the space is deformed under action of such loads that the midplanes of layers are the symmetry planes. Taking into account that the stress state in compound layers between two planes of symmetry is the same, we consider only one layer. Then, using the generalized Fourier transformation the discontinuous solutions for two-component layer with interphase defects are built. Using obtained discontinuous solutions, as an example, the governing singular integral solutions for two stated problems are written. In one case the defect is a tunnel crack on the one edge of which the loads are given and, in the other case, the given load is acting on one edge of crack and the absolutely rigid thin inclusion is welded on the other edge. In both cases the exact solutions are built.

The study further addresses the antiplane stress state of piecewise homogeneous space, containing doubly periodic system of tunnel interphase defects on junction planes of the heterogeneous layers. Taking into account the periodicity of the stated problem along the junction of heterogeneous layers and using discontinuous solutions of problems, obtained in case of parallel interphase defects, the discontinuous solutions of considered case are built.

On the basis of these solutions a governing system of equations is written for governing system of equations case for doubly periodic system of tunnel interphase cracks with given stresses on both edges or stresses given on one and displacements on the other edges are written. Solutions for the mentioned problems are built through the numerical-analytical method of mechanical quadratures. The character of changes for jump functions of edges of cracks, along with intensity factors of failure stresses and contact stresses on the edge of inclusion coupled with matrix are studied depending on geometrical, physical and mechanical parameters.
The plane stress state of piecewise-homogeneous plane, formed by alternate junction of two heterogeneous strips with same width is considered. The plane contains periodic (with period)

same linear interphase thin, absolutely rigid inclusions on lines of junctions of strips along line , consisting of finite number of disjoint intervals and symmetrically situated about lines . It's assumed that plane is deformed under action of symmetrically relative to the lines balanced loads, applied to the defects such that the lines and are the lines of symmetry. The stated problem is formulated as a problem for piecewise homogeneous rectangle (base cell) occupying the region of the plane, on the bounds of which the conditions of symmetry are given, and there are linear defects on the junction lines of heterogeneous rectangles along line . Using Airy stress function the discontinuous solutions of equations of plane elasticity theory for two-component rectangular are obtained.

On the basis of these solutions, as an example, the systems of governing singular integral equations for two stated problems are deduced. In one case the defect is a crack with given stress components on both edge, and in second case there are symmetrically situated two interphase inclusions with equal length, which are under action of normal and horizontal concentrated loads, as well as moments on base cell.   The solutions of stated problems are again built by the numerical-analytical method of mechanical quadratures. The numerical analysis of stated problems is fulfilled. The character of changing of the cracks' opening and integral at the end-points of crack in first problem, as well as the changing of contact stresses, acting on long edges of inclusions and rotating angle of inclusions in second problem, depending on geometrical and physical and mechanical parameters, are studied.

REFERENCE

[1] Panasyuk V., Savruk M., Datsyshyn A. Distribution of stresses near cracks in plates and shells.// Kiev, Naukova Dumka, 1076, 443pp. (in Russian).

[2] Bardzokas D.I., Filshtinskiy L.A., Filshtinskiy M.L. Actual problems of coupled physical fields in deformable bodies, Vol.1 – Moscow-Izhevsk, 2010, 864 pp. (in Russian).

[3] Grigolyuk E.I., Filshtinskiy L.A. Regular piecewise structures with defects.// Fizmatlit, 1994, 332pp. (in Russian).

[4] Hakobyan V.N., Dashtoyan L.L. Doubly periodic problems for piecewise homogeneous plane with cracks.// Proceedings of IV international conference "Topical Problems of Continuum Mechanics", pp.33-37. (in Russian).

[5] Hakobyan V.N., Hakobyan L.V. Stress state of piecewise homogeneous space with periodical system of parallel interphase defects.// Proceedings of IV international conference "Topical Problems of Continuum Mechanics", pp.28-32. (in Russian).