Mutual influence of three-dimensional cracks in an elastic body

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One of the actual problems of modern fracture mechanics is the problem of studying the stress concentration in the vicinity of cracks in three-dimensional space. Currently, there are well-developed effective methods for solving two-dimensional crack problems. One of such methods is the method of discontinuous displacements [1]. The advantage of this method is the ability to accurately perform the equations of the theory of elasticity. In this case, the boundary conditions are satisfied on a discrete set of boundary points, which can be made arbitrarily dense. For the numerical solution of three-dimensional problems of solid deformable body mechanics, finite element methods are most often used. But their use for cracks in three-dimensional space is faced with great difficulties, since the construction of stress and displacement fields in the vicinity of cracks requires the construction of a fairly small, adapted to the geometry of cracks, finite element mesh. In the presence of a system of cracks of complex geometry, the task becomes virtually impossible. In this paper, we propose a numerical boundary element method that implements the method of discontinuous displacements in three-dimensional space. The advantage of this method is that only the crack surface modeling the elastic medium rupture is broken into finite elements. This reduces the dimensions of the problem at the stage of its solution. From the point of view of mathematical theory, this approach is one of the implementations of the method of solution decomposition by "non-orthogonal"functions [2]. After the numerical determination of the expansion coefficients, we actually have an analytical representation of the solution in the form of a finite series within the domain. From the point of view of memory, we need to store only the expansion coefficients found, allowing then to find any required characteristics at any point in the solution area. It is essential from the point of view of simplicity of practical use of the received decision. The programs are implemented by the authors in the language of C. the program is tested by comparison with the known analytical solutions [3],[4],[5]. The comparison showed good qualitative and quantitative compliance with the available results of other authors. A numerical study of the problem of mutual influence of disc-shaped plane cracks is carried out. Round and elliptic plane cracks of different mutual orientation and arrangement in space were considered [6],[7]. As a measure of mutual influence the values of stress intensity factors were used. Studies have shown that in contrast to the plane deformation cracks, for three-dimensional cracks the distance of their significant mutual influence is much smaller. This fact speaks in favor of the use of three-dimensional formulation of problems of strength mechanics in the presence of defects in the form of cracks. The work is executed at support of RFBR grant No. 19-07-01111.