

THE APPROXIMATED ANALYTICAL SOLUTIONS OF AXISYMMETRIC CONTACT PROBLEMS FOR THE COATING OF COMPLICATED STRUCTURE

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Summary We suggest the new effective method of construction of analytical approximations of kernels' transforms of the dual integral equations of contact problems for inhomogeneous environments by the functions of a special kind. On the basis of transforms' approximation of high accuracy, analytical solutions of contact problems for materials with coatings of complicated structure are constructed.

Under consideration there are axisymmetric contact problems for the coated materials. It is supposed that elastic properties of coatings vary only on depth. Using a method of integral transformations, the solution of contact problems is reduced to the solution of the dual integral equations. Generally kernels' transforms of these equations can be constructed only numerically. Traditionally the construction of the approximated analytical solutions of contact problems for thin coatings, thick coatings as well as for the coatings, comparable on a thickness with the sizes of a stamp, requires the application of various methods (a regular asymptotic method, singular asymptotic method, methods of orthogonal multinomials, collocations, etc.). Each of the applied methods is effective in its own area of values of characteristic geometrical parameter of a problem. The given work develops the approximated analytical method of the solution of the dual integral equations, generated by contact problems of the elasticity theory for inhomogeneous coatings. We suggest the new effective method of construction of analytical approximations of kernels' transforms of the dual integral equations of contact problems for inhomogeneous environments by the functions of a special kind. On the basis of transforms' approximation of high accuracy, analytical solutions of contact problems for materials with coatings of complicated structure are constructed. The method is dual-sided asymptotically exact and it allows receiving in the uniform analytical form the approximated solution of contact problems, effective for coatings of any thickness. There have been considered problems for the elastic environment with an inhomogeneous coating of periodic structure for which the gradient of change of elastic properties repeatedly changes a sign (up to 50 times). Nonmonotonic verification of elastic properties in a coating, connected with a sign-variable gradient of change of elastic properties, makes essential impact on properties kernels' transforms of these integral equations. There are constructed the approximated analytical solutions of contact problems for the materials with an inhomogeneous coatings at which the rigidity of a substrate many times exceeds the rigidity of a coating (up to 1000 times). Such model corresponds to a model of the basis in the form of an inhomogeneous layer on a nondeformable substrate. The estimation of an error of the constructed approximated analytical solutions is made, which is important for appendices. We have investigated the influence of the structure of the functionally-gradient coatings on a distribution of contact stresses acting under a stamp, as well as the influence on the stresses fields, deformations and displacement inside the elastic basis.

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