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ANALYSIS OF MULTILAYER SHELL ELEMENTS OF VEHICLE STRUCTURES UNDER STATIC LOADING

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A method for solving two-dimensional problems of static deformation of multilayer shells of complex geometry of ground vehicles and aircraft elements has been developed. The method performs strength calculations of both multilayer and homogeneous shell elements in a refined formulation.

When creating modern vehicles, elements such as multilayer shells and plates made of new non-metallic materials are increasingly used [1, 2]. This is due to the fact that nowadays it is practically impossible to satisfy the whole set of requirements for ground vehicles and aircraft using only traditional structural schemes and solutions [3, 4]. Multilayer structural elements composed of layers with different mechanical, thermophysical and other characteristics can have a unique set of properties, such as high strength and reliability, good thermal insulation and aerodynamic qualities at a relatively low mass [5, 6].

Structural elements are subjected during operation to significant external loads and thermal fields and operate, as a rule, under conditions of the stress-strain state close to the limit state [7, 8]. This leads to increased requirements to the accuracy of strength calculations of such structures and is the reason for intensive research both in the field of theory and methods of their calculation. The purpose of the present work is to construct a method for solving static and thermoelastic problems for closed shells of rotation and two-dimensional problems for unclosed shells of arbitrary shape, which are elements of structures of ground vehicles and aircraft.

In the framework of the Grigoliuk-Chulkov kinematic model, the basic relations of the linear theory of non-hollow multilayer shells of complex geometry with and without transverse compression are constructed. The obtained relations are applicable to the study of the stress-strain state of shells with layers of insignificantly varying thickness and non-canonical outlines of the support contour. The components of the displacement vectors of the face surfaces of the outer layers and the contact surfaces of the inner layers are taken as the sought functions, which leads to the matrix of differential operators of the solving system of equations. This allowed us to significantly simplify the construction of the algorithm for the numerical solution of the problem. A numerical method for solving axisymmetric problems of statics and thermoelasticity of multilayer shells of rotation with arbitrary fixing conditions is developed on the basis of the obtained relations. Numerical investigation of the

convergence of the developed method of calculation has been carried out and the reliability of the results obtained on its basis has been established by comparison with the solutions available in the literature.

Calculations have been made to study the static strength of a number of structural elements of complex geometry under the action of surface and thermal loads on them. In the future, the method can be used to study the stress-strain state of a number of real shell structures of aircraft and ground vehicles, such as glazing, fairings, and power panels.

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