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THERMOELASTIC DEFORMATION OF PLATES OF VARIABLE THICKNESS

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An approach to the study of the thermal stress state of plates of stepwise variable thickness has been developed. The approach is based on minimization of the total strain energy functional and subsequent continuation of the solution by the parameter.

The progress of technology has led to the widespread use of a variety of thin-walled structures, whose elements are plates and shells that are not only under the action of mechanical loads, but also high temperature field [1, 2]. Problems of temperature stresses arise in mechanical engineering, aviation, metallurgy, construction and other fields where strength issues related to temperature effects can be of great, and often decisive, importance [3, 4]. Analysis of literature sources shows that thin-walled shell structures are widely used in various fields of engineering [5, 6]. To give greater rigidity, the thin-walled part of plates and shells is reinforced with stiffening ribs [7]. Structures can be subjected not only to mechanical but also to thermal effects. Strength and stability calculations of such structures play an important role in the design of modern machines, apparatuses and structures [8]. The behavior of smooth thin-walled structures and structures of stepped-variable thickness, which are in the temperature field and allow deflections commensurate with the thickness, are not sufficiently studied and are the object of our study.

For the potential energy of deformation of a thermally stressed shell of variable thickness, the expression of potential energy for hollow shells of stepwise variable thickness at finite deflections in the case of the kinematic model of the classical theory is written. To minimize the potential energy functional, the Ritz method is applied, which leads to a system of nonlinear algebraic equations with respect to the coefficients of the expansion of the desired functions in series over the systems of basic functions. To solve the system of nonlinear algebraic equations, the method of successive loadings is used, which is a special case of the method of continuation of the solution by parameter and reduces the solution of the initial nonlinear system of algebraic equations to the successive solution of systems of linear algebraic equations. Since the order of derivatives of the desired functions in the total strain energy functional is two times lower than in the equilibrium equations, the coefficients of the system of linear algebraic equations are significantly simplified. The proposed method was tested on the solution of problems of deformation of square plates under the action of uniform temperature. Further, the problems for ribbed plates under the action of a temperature field varying in thickness were solved. The stress-strain state of plates with a different number of ribs was investigated for the action of the temperature field at the heat-

insulated side surface of the ribs. Calculations were carried out when the temperature field was approximated by a quadratic dependence along the plate thickness.

The developed method can be applied to study the thermal stress state of important structural elements in various areas of transportation engineering, aircraft construction and civil engineering.

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