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«ТЕХНІЧНИЙ ПРОГРЕС В АПК»

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MATHEMATICAL MODELING OF THE STRESS-STRAIN STATE OF ROTATIONAL STRUCTURES UNDER NON-AXISYMMETRIC HEAT TRANSFER

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A method has been developed for determining the thermal elastic-plastic stress-strain state of rotationally symmetric bodies that are not closed in the circumferential direction under convective heat transfer. This method can be used in strength analyses of components in agro-industrial structures subjected to non-axisymmetric loading processes.

Many components of various structures, designed as three-dimensional bodies of simple and complex shapes, including those used in agricultural and industrial equipment, operate under conditions of uneven heating due to the action of surface and volumetric forces. This causes stresses to develop within them, which in certain areas may exceed the material's yield strength [1–3].

Rotational bodies with complex meridional cross-sections that are not closed in the circumferential direction, and which are subjected to non-axisymmetric temperature fields and external forces, are widely used as structural components in steam and gas turbines, jet engines, internal combustion engines, and other mechanical engineering structures [4–6]. When studying the strength of such structural elements, it is necessary to consider not only the stress distribution within the elastic range of the material but also beyond it. Therefore, the study of the thermal elastic-plastic stress-strain state of bodies of revolution that are not closed in the circumferential direction under the action of a non-axisymmetric load is an important and relevant problem in mathematical modeling in mechanics. The behavior of a material beyond the elastic limit differs significantly from its behavior in the elastic state. Currently, there are numerous theories of plasticity, which describe the stress-strain state during loading with varying degrees of accuracy.

The aim of this study is to develop a methodology for determining the thermal elastic-plastic stress-strain state of bodies of revolution that are not closed in the circumferential direction and are subjected to non-axisymmetric thermal and force fields. The nonlinear equations of state are linearized using the method of variable elastic constants. The calculation is performed using the finite element method. A ring

element with a triangular meridional cross-section is selected as the finite element. Temperature and displacements across the finite element are approximated by an incomplete quadratic polynomial.

The problem of determining the thermal elastic-plastic state of a cylindrical panel subjected to internal pressure and a temperature field has been solved. The solution of the problems has shown that accounting for plastic deformations can lead to a change in the values of stress components (in absolute magnitude) by more than a factor of 1.5 in the domain of their maximum values. It has been established that the body's open-ended nature in the circumferential direction leads to a pronounced edge effect near the ends.

Conclusion.

A method was offered for performing strength calculations for structural components subjected to non-axisymmetric loading. The results of investigations can be used for analysis of the thermal state of equipment in the agro-industrial sector.

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