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MODELLING OF CYCLICALLY SYMMETRIC STRUCTURES FOR STRENGTH ANALYSIS

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A methodology for the investigation of spatial cyclically symmetric structures with radial ribs is developed. The possibility of optimal designing covers using nonlinear mathematical programming methods at the design stage in order to improve their strength is demonstrated.

In recent years, due to competition, the level of requirements for the efficiency and reliability of power equipment has increased dramatically [1, 2]. This problem is solved by reconstructing and replacing physically worn-out and obsolete equipment [3, 4].

Particular attention is paid to the supporting structures and turbine impellers, which are dynamically affected by the water flow. The bearing structures include the turbine cover, which is a spatial structure consisting of thin-walled bodies of revolution (meridional multi-connected plates). It not only restricts the turbine flow path from above, but also serves as a load-bearing structure that absorbs significant loads from mass forces and hydrodynamic pressure.

The problem consists in an investigation of the stress-strained state of the initial and modified cover of a rotary-blade hydraulic turbine under the influence of a statistical axisymmetric load and it is solved by the finite element method [5, 6]. The aim of this study is to develop a methodology for calculating spatial cyclically symmetric structures (hydroturbine covers) with radial ribs.

Calculations for a rotary-blade hydraulic turbine have been performed for a fully functioning state, taking into account the weight and distributed hydraulic loads. To solve the problem, a triangular elastic shell finite element with three nodes is used. The model is divided into finite elements, after which cyclic symmetry conditions, as well as the conditions for fixing and loading the structure, are introduced at the boundaries with neighboring sectors. Round holes are provided in the ribs to accommodate the mechanisms and reduce the weight of the assembly. The ring plates have shaped holes in the form of a blade profile, which are designed to dismantle and repair individual blades without completely disassembling the guide apparatus. Calculations of the rotary-blade hydraulic turbine cover were performed for the normal operating mode. Weight and distributed hydraulic loads were taken into account. As a result of calculating the initial structure, the values of stress intensity and axial displacements

were obtained. It has been established that the maximal stresses do not exceed the limiting values in the initial and modified constructions.

The obtained results demonstrate the possibility of optimal designing covers using nonlinear mathematical programming methods [7, 8] at the design stage in order to improve their strength, decrease a material consumption without reducing working and technological characteristics.

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