GAS TURBINE ENGINES ROTORS DYNAMICAL STRESSES CAUSED BY THE TURBULENT GAS FLOW LOAD

Morhun S.
Admiral Makarov National University of Shipbuilding,
Mikolaiv

The task of the gas turbine rotor stress-strain state, caused by the turbulent gas flow load determining is given. It is also assumed that the considered system of solid bodies (impellers and a shaft) has the properties of cyclic symmetry. So it can be interpreted as a set of q subsystems (sections) with the same geometric, inertial and stiffness properties [1]. In this case, q determines the system's order of symmetry. So a section of the whole rotor generally includes a superposition of three impellers' sections and a shaft section.

The considered mechanical deformable system energy state could be described by Lagrange variation principle. Thus:

$$- \quad \begin{matrix} \delta \boldsymbol{L} = 0 \\ \boldsymbol{L = \Pi - T} \end{matrix} \tag{1}$$

where L – Lagrange function; Π – potential energy of system's resistance to deformation; T – the kinetic energy of the system vibration.

After FEM approximation [2] the main equation of the mechanical system balance (1) is transformed to:

$$- \quad [\boldsymbol{M}]\left\{\frac{\boldsymbol{d}^2\delta}{\boldsymbol{dt}^2}\right\} + [\boldsymbol{C}]\left\{\frac{\boldsymbol{d}\delta}{\boldsymbol{dt}}\right\} + [\boldsymbol{K}]\{\delta\} = \{\boldsymbol{p}\} \tag{2}$$

where $[K]$ – global stiffness matrix of finite elements model; $[M]$ – global mass matrix of finite elements model; $[C]$ – global damper matrix of finite elements model $\{\delta\}$ – vector of finite elements nodes generalized displacement; $\{p\}$ – pressure caused by the gas flow.

The value of pressure field, caused by the influence of non-stationary gas-dynamic flow is calculated by methodology, given in [2]. Dependences between generalized displacement and deformation are given in [1]. Thus the field of the gas turbine engine rotor dynamic stresses can be found as follows:

$$- \quad \sigma = [D] \cdot \{\varepsilon\} \tag{3}$$

where D − is the elasticity matrix; ε – deformation vector.

Література:

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