

USING THE FINITE DIFFERENCES METHOD FOR ESTIMATION OF BUCKLING UNDER LONGITUDINAL COMPRESSION OF CLADDING OF FUEL RODS OF NUCLEAR REACTORS

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It is well-known that the claddings of fuel rods of the most modern nuclear reactors have the significant smaller transverse sizes comparing the longitudinal size and gets the longitudinal compression in the core of nuclear reactors under exploitation. Besides, it is well-known also, that the compression of the rod can lead to its buckling which lead to appear the bending of this rod. It is clearly understood, that bending the cladding of fuel rods due to buckling can disturb the normal operation of the control and safety systems due to preventing of necessary moving the control rods. The purpose of this research is to consider the opportunity of the finite differences method for estimating the buckling under longitudinal compression the cladding of fuel rods of nuclear reactors.

The mathematical formulation of the problem about buckling under the longitudinal compression of the cladding of fuel rods is represented as the linear homogeneous fourth-ordered differential equation relative the buckling deflection of the cladding considered as the thin rod with necessary boundary conditions. The boundary conditions can represent the different kinds of joints, including the cylindrical joints, the rigid as well as the elastic joints. Using the finite differences method leads to linear homogeneous algebraic equations for the nodal values of the cladding deflection. The condition of existence the non-zero solution of these homogeneous algebraic equations leads to the characteristic equation for finding the critical compressive forces, corresponding the buckling of the cladding. This characteristic equation leads to the algebraic eigenvalues and eigenvectors problem, such as the eigenvalues represent the critical compressive forces, but the eigenvectors represent the modes of the buckling corresponded these critical compressive forces. Properties of the matrices, presenting in this eigenvalues and eigenvectors problem for estimating the buckling of the cladding allow using the QR-method for computational estimating the eigenvalues and eigenvectors.

The computations of the critical compressive forces, leading to the buckling of the cladding, are realized by the software especially designed using the C# programming language as well as the FORTRAN programming language. It is understandable, that the FORTRAN programming language is the more suitable for the computations, but the C# programming language is more suitable for design the software system tools like the user dialogs, etc., which are the significant volume of the designed software. Results of computing the critical compressive forces of the cladding of fuel rods with cylindrical jointed edges show the full corresponding with the analytical exact solution, and the opportunity on using the finite differences method in the more complex problems, including the cases of the elastic jointed cladding.