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Symplectic system based analytical solution for bending of rectangular orthotropic plates on Winkler elastic foundation

Wei-An Yao, Xiao-Fei Hu, Feng Xiao

State Key Laboratory of Structural Analysis for Industrial Equipment, Dalian University of Technology, 116024 Dalian, China

Abstract This paper analyses the bending of rectangular orthotropic plates on a Winkler elastic foundation. Appropriate definition of symplectic inner product and symplectic space formed by generalized displacements establish dual variables and dual equations in the symplectic space. The operator matrix of the equation set is proven to be a Hamilton operator matrix. Separation of variables and eigenfunction expansion creates a basis for analyzing the bending of rectangular orthotropic plates on Winkler elastic foundation and obtaining solutions for plates having any boundary condition. There is discussion of symplectic eigenvalue problems of orthotropic plates under two typical boundary conditions,with opposite sides simply supported and opposite sides clamped. Transcendental equations of eigenvalues and symplectic eigenvectors in analytical form given. Analytical solutions using two examples are presented to show the use of the new methods described in this paper. To verify the accuracy and convergence, a fully simply supported plate that is fully and simply supported under uniformly distributed load is used to compare the classical Navier method, the Levy method and the new method. Results show that the new technique has good accuracy and better convergence speed than other methods, especially in relation to internal forces. A fully clamped rectangular plate on Winkler foundation is solved to validate application of the new methods, with solutions compared to those produced by the Galerkin method.

Keywords: Orthotropic plate Symplectic space Winkler elastic foundation Analytical solution

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