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Theoretical-experimental method for determination of aerodynamic damping component of test samples with diamond-shaped cross-section

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Abstract

© PNRPU.A numerical method for processing of experimental vibration data has been developed to find the lowest experimental frequency and amplitude dependences of the logarithmic decrement which are used to determine damping properties of test-samples. The logarithmic decrement (LD) is determined by the experimental decay curve obtained from the tip point amplitude measurements of test-samples during their flexural vibrations and approximated by the sum of two exponents with four parameters determined by a direct search of the objective function depending on these parameters. The conducted numerical experiments confirmed the reliability of the developed method. It is shown that the material of the test samples with a diamond-shaped cross-section must have stable and low damping properties for a reliable determination of the experimental aerodynamical damping component. Duralumin alloys absolutely meet these requirements. The damping matrix of the finite element model of the testsample with an arbitrary cross-sectional shape is constructed in the case of the amplitudeindependent internal friction in the material. The internal damping parameter which specifies the material damping properties is obtained. The experimental aerodynamic component of damping is obtained from the series of test-samples with the diamond-shape cross section. It has been noted that the elasticity modulus of duralumin D16 AT is frequency dependent. An iterative algorithm is developed to determine the lowest vibration frequency of the test-sample considering this dependence. The conducted numerical experiments using the test-samples with the specified cross-section confirm the reliability of the developed algorithm. The theoretical and experimental method is developed to construct the structural formulae to determine the aerodynamic component of damping for the test-samples with the diamondshaped cross-section. The method is based on the modification of the basic formulae for thin plates with the constant thickness and the experimental data on the damping properties obtained for the series of test samples with the specified cross-sectional shape. The reliability of the obtained structural formulae has been confirmed by the performed numerical experiments.

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Keywords

Direct search, Dynamic modulus of elasticity, Finite element, Logarithmic decrement of oscillations, Objective function, The internal damping parameter