21-22 ТРАВНЯ

2025

Матеріали XX МІЖНАРОДНОЇ НАУКОВО-ПРАКТИЧНОЇ КОНФЕРЕНЦІЇ

«ТЕХНІЧНИЙ ПРОГРЕС В АПК»

Факультет мехатроніки та інжинірингу

Державний біотехнологічний університет

ХАРКІВ, Україна

https://biotechuniv.edu.ua

UDC 539.3, 621.311

MATHEMATICAL MODELING OF CYLINDRICAL SHELL VIBRATIONS WITH CONSIDERATION OF TEMPERATURE FIELDS

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Mathematical models of vibrations of cylindrical shells under the action of alternating loads and temperature field are proposed. The results of the study can be used to evaluate the strength and reliability of various structures.

Numerous processes and phenomena occurring in physical, chemical, biological, economic and social non-equilibrium systems are analyzed by complex systems of differential equations [1–3]. Not only theoretical but also practically important classes of problems arise when there is a need to control the system. But despite the large number of publications, many questions remain open. In industry, structures made in the form of thin single-layer and multilayer shells of rotation are widely used. During operation they can be exposed to force and thermal loads. The problem of reliable operation of structures operating in conditions of intensive thermal and mechanical influences is one of the most important from the practical point of view in modern engineering, and theoretical numerical studies of the occurrence of vibrations in such a structure are also of interest [4–6]. Temperature stresses are among the main factors to be considered when selecting the modes of heating bodies [7-9].

The aim of the study is to build mathematical models of complex vibrations of mechanical systems in the form of flexible cylindrical shells, cylindrical panels on a rectangular plan, which are under the action of alternating loads and temperature field, as well as the creation of effective mathematical methods and algorithms for solving such problems.

To achieve this goal, mathematical models have been developed for vibrations of cylindrical shells and panels on a rectangular plan, located in a temperature field, under the action of distributed or local alternating transverse load and longitudinal periodic loads [10]. An algorithm for numerical realization of vibrational modes for qualitative study of complex vibrations of the above shell systems is proposed. The influence of temperature field and alternating force loads on complex vibrations of shell systems depending on control parameters (amplitude of load excitation, temperature intensity) has been studied. The results of the study can be used to assess

the strength and reliability of structures in various branches of engineering.

References:

1. Kurennov S., Smetankina N., Pavlikov V., Dvoretskaya D., Radchenko V. Mathematical model of the stress state of the antenna radome joint with the load-bearing edging of the skin cutout. *International Conference on Reliable Systems Engineering (ICoRSE)-2021. Lecture Notes in Networks and Systems.* Springer, Cham, 2022. Vol. 305. P. 287–295.

2. Kuznetsov B.I., Nikitina T.B., Bovdui I.V., Chunikhin K.V., Kolomiets V.V., Kobylianskyi B.B. The method for design of combined electromagnetic shield for overhead power lines magnetic field. *Electrical Engineering & Electromechanics*. 2024. No. 3. P. 22–30.

3. Merculov V., Kostin M., Martynenko G., Smetankina N., Martynenko V. Force simulation of bird strike issues of aircraft turbojet engine fan blades. *International Conference on Reliable Systems Engineering (ICoRSE)-2021. Lecture Notes in Networks and Systems.* Springer, Cham, 2022. Vol. 305. P. 129–141.

4. Smetankina N.V., Postnyi O.V., Misura S.Yu., Merkulova A.I., Merkulov D.O. Optimal design of layered cylindrical shells with minimum weight under impulse loading. In: *2021 IEEE 2nd KhPI Week on Advanced Technology (KhPIWeek).* 2021. P. 506–509.

5. Smetankina N., Ugrimov S., Kravchenko I., Ivchenko D. Simulating the process of a bird striking a rigid target. *Advances in Design, Simulation and Manufacturing II. DSMIE 2019. Lecture Notes in Mechanical Engineering*. Springer, Cham, 2020. P. 711–721.

6. Місюра С.Ю., Сметанкіна Н.В., Місюра Є.Ю. Раціональне моделювання кришки гідротурбін для аналізу міцності. *Вісник НТУ «ХПІ». Сер.: Динаміка і міцність машин*. 2019. № 1. С. 34–39.

7. Smetankina N.V., Postnyi O.V., Merkulova A.I., Merkulov D.O. Modeling of non-stationary temperature fields in multilayer shells with film heat sources. In: *2020 IEEE KhPI Week on Advanced Technology (KhPIWeek).* 2020. P. 242–246.

8. Smetankina N., Kravchenko I., Merculov V., Ivchenko D., Malykhina A. Modelling of bird strike on an aircraft glazing. *Integrated Computer Technologies in Mechanical Engineering. Series "Advances in Intelligent Systems and Computing"*. Springer, Cham, 2020. Vol. 1113. P. 289–297.

9. Malykhina A.I., Merkulov D.O., Postnyi O.V., Smetankina N.V. Stationary problem of heat conductivity for complex-shape multilayer plates. *Bulletin of V.N. Karazin Kharkiv National University. Series "Mathematical modeling. Information technology. Automated control system"*. 2019. Vol. 41. P. 46–54.

10. Smetankina N.V. Non-stationary deformation, thermal elasticity and optimisation of laminated plates and cylindrical shells. Kharkiv: Miskdruk Publishers, 2011. 376 p.