



About the author

Prof. Alexander Petrovich Leschenko was born in 1939. He has got PhD degree in Civil Engineering.

Prof. Leschenko has 3 Certificates on his discoveries in the field of Structural Mechanics:

- 1) Certificate DO № 000008 on discovery *Principle of pairing of force factors*;
- 2) Certificate DO № 000006 on discovery *Phenomena of separating torsional strains of elastic bars*;
- 3) Certificate DO № 000007 on discovery *Specific analogy law in stability and oscillation of an elastic system*;

and 2 patents on his inventions:

- 1) Patent № 2150098 of 27.05.2000 on invention *Testing method for buckling failure of metal constructions*;
- 2) Patent № 542435 of 21.09.1978 on invention *Breakdown controller of pile driver*.

His current research concerns various aspects of Civil Engineering and Structural Mechanics.

The publication list comprises the following books:

- *Structural mechanics of thin-walled structures* (in Russian), Moscow, Stroyizdat, 1989;
- *New principles in structural mechanics of thin-walled structures* (in Russian), Moscow, Stroyizdat, 1995;
- *Fundamental structural mechanics of elastic systems* (in Russian), Taganrog, Sphinx, 2003.

A. P. Leschenko

**THE FUNDAMENTAL
STRUCTURAL
MECHANICS
OF ELASTIC SYSTEMS**

Oscillations and flutter

MOSCOW



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Leschenko Alexander Petrovich

The fundamental structural mechanics of elastic systems: Oscillations and flutter.

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A. P. Leschenko has offered a completely new approach to structural mechanics, which allowed for a unique technique for structural engineering to be developed. This new method is based on the following three discoveries made by the author:

- Phenomenon of separating torsional strains of elastic bars;
- Specific law of analogy in stability and oscillation of elastic systems;
- Principle of force factors pairing in structural mechanics.

All actual approaches and theories of structural mechanics widely employ such an abstract concept as generalized force, neglecting, however, a definite and practical concept of external force factor. In author's opinion, this breaks the interrelations between the external and internal forces acting on structures and the strains occurring in the structures, which leads to an implicit violation of the classical mechanics laws, namely the law of energy conservation, the Lagrange principle, and Newton's laws. It should be stressed that Leschenko does not suggest that one concept should be simply replaced by the other, but interrelates the external action with other forces and factors concurrently acting on the structure.

Thus, the author has proposed to consider any elastic system as based on three permanently acting factors: 1) external forces; 2) internal forces; and 3) elastic strains; and indicated the principles linking the effects of these factors. Leschenko has developed a graphical scheme (the so-called *triad*) for an analysis of elastic systems. The *triad* analysis of elastic systems has enabled to reveal great contradictions in the available structural calculations of plates, shells and bars. On the other hand, the new method has allowed for an adequate model of stress-and-strain state of constructions to be developed, which, for the first time ever, has made it possible to predict with a high accuracy the moment of structural failure.

As main advantages of the new method we can list comparatively quick calculations of all types of structures, the examination and verification of design solutions, and the detection of critical loads and weak points of constructions. All these result in a considerable saving of materials, which is accompanied by improving the safety of constructions.

The text of this book has been supplied entirely by the author.


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Introduction and a brief historical review

The theory of oscillation processes is the field of the science associated with mathematics, mechanics and general physics.

I. Newton, L. Euler, LaGrange and other classics of mechanics laid the basement of a modern theory of mechanical oscillations.

Khristian Huigens, the well-known Holland scientist and the watchmaker (1629-1695) contributed greatly into the theory of oscillation. He created izochronic cycloidal pendulum and was the first to observe selfsynchronization of associated oscillating systems.

J. Y. Strett (Lord Raley, 1842-1919) a British scientist created a systematic teaching on oscillation forms about their attenuation in the XIX century, he investigated a problem on plates' and sheaths' vibration in details.

At the same time A. Poincarre (1854-1912) for the first time proposed an idea of a qualitative analysis of oscillating systems using depiction of motion at a phase plane and related this depiction to the facts of periodical and nonperiodical motions, stability and so on.

He merited also a mathematical analysis of complex linear oscillations which he conceived in the form of a great number of ordinary linear oscillations.

The soviet scientists L. I. Mandelshtam (1879-1944), N. D. Papaleksi (1880-1947), A. A. Andropov (1901-1952), N. M. Krylov (1879-1955), N. N. Bogolyubov, Yu. A. Mitroopolsky, A. N. Krylov, V. V. Bolotin, I.I. Blechman, Yu. I. Neimark, Ya. G. Panovko, G. F. Ganiyev and others contributed greatly in creation of modern methods of theoretical analysis of oscillating systems.

Two directions may be singled out in the present science on oscillations:

1. Development of theory, schematization of real objects, creation of idealized models using the laws of mechanics and mathematical apparatus;
2. Application of instruments for measurement of the values characterizing actual motion of one or another object. Experimental grounding of the theory by vibrodiagnostical methods.

The author carried out his investigations by these two directions.

He passed from the development of the linear theory of stability that has been covered in the previous books to elaboration of the linear theory of oscillations built on an idea of analogy in a form of free oscillations of constructions.

Varying a load, specifying the concepts of dynamical stability and instability taking into account the load's effect by introducing the coefficient of the load, the author offers new scientific results which agree well with the experiment.