



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**

Strength

MOSCOW



URSS

Leschenko Alexander Petrovich

The fundamental structural mechanics of elastic systems: Strength.

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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

The second half of the Twentieth century is characterized with great progress in science and technique. Progress in science and technique in Russia is coincided with changes in man's life and with reforms of Russian society. Ideas of these reforms are especially actual for such a field of man's activity as science.

This book might be considered as development and application to another A. Leschenko's book — "Building mechanics of thin-walled constructions" (USSR, Moscow, 'Strojizdat', 1989), in which the new conceptions of strength, stability and dynamics of thin-walled constructions have been discussed.

The detail and deep theoretical analysis of building mechanics theory, on which the modern methods of thin-walled constructions are based, has allowed to the author to open the contradictions in modern conceptions of strength, stability and dynamics of thin-walled constructions.

The author has introduced the new law of dividing torsional strains in theory of strength of thin-walled bars, and that has allowed to get the new linear differential simultaneous equations of strength. Besides, applying by the author the specific law of analogy in theory of stability and oscillation has allowed to develop linear theories of stability and oscillations which are described with linear differential simultaneous equations and based on the new criteria of stability and dynamic balance:

$$T_r \leq T_f.$$

Here for the first time the conception of elastic system has been formulated as the view at the three fundamental physical factors:

- 1) External force factor;
- 2) Internal force factor;
- 3) Elastic strains.

It has been shown their interactions in laws of physics and mechanics. These models of interactions have allowed to show all contradictions in modern theories of strength, stability and dynamics of thin-walled constructions and to formulate the main law of cross-section method (principle of pairing of force factors).

At any cross-section loaded of elastic body being under load there are always two force factors: 1) external force factor which is the sum of projections (or moments) of all external forces of the cut off part of elastic body and 2) internal force factor (integral characteristics), which, due to condition of

equilibrium of the cut off part, equals to external force factor and acts in opposite direction.

Ignoring this principle violates the main laws of mechanics (see triads).

The developed new adequate theoretical models of strength, stability and dynamics of the thin-walled constructions considerably specify physics of the phenomena and simplify designing.

Experimental proving of new ideas as the main criteria of truth has been discussed a lot in the book.

The development of the new branches of technique such as cosmonautics, missile manufacturing, researching hydrosphere depths with the help of deep-water apparatus, etc. makes engineers and designers to solve more and more complicated problems concerning evaluation of constructions for strength, stability and dynamics.

The main goal of this book is to help the practical engineers in solution such problems.

The book consists of 7 chapters. In chapter I the analysis of current conception of the strength of elastic systems, its consistency harmony with Lagrange—Castigliano's principles and variation mechanics principles have been discussed. Here the analysis of contradictions in the current theory of thin-walled bars are paid attention to.

In Chapter II the earlier unknown law of dividing torsional strain is introduced in the strength theory and on its base according to variation mechanics principles the new conception of thin-walled construction strength is being developed. In Chapter III the solution methods of various engineering problems of strength evaluation of beams and bars are developed according to methods suggested by the author.

The Chapter IV is devoted to the experimental proving of the law of dividing torsional strains law. The new strength conceptions are proved on the base of experiments of designing J-beam bending center and fibre strains of beams and bars.

In Chapter V the detail analysis of the elastic system conception is given, the current conception is corrected and conclusions are made.

Chapter VI is devoted to the development of new conception of bending thin plates and slanting cylindrical shells. Here Karman's conception of bending plates in details, is discussed its contradictions with mechanics laws are shown and the new approach to solution of the problem of bending plates and shell is proved.

In Chapter VII mechatronic units and their using in analyzing strength of J-beams are described.

The analysis of corrections says that the using of scientific results introduced in the book in to practice of designing and building means the reform of the whole science of structural mechanics.