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TASKS OF LABORATORIES OF DYNAMICS BUILDINGS AND STRUCTURES

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Statement of the problem. The report analyzes a set of problems associated with the dynamics of buildings and structures. Moreover, not only the traditionally problematic tasks of clarification, for example, nonlinear properties of models and types of loads, but also new problems that reveal new possibilities for studying and using the dynamic characteristics of objects. In the 21st century, a new look is needed on the dangers of dynamic impacts and on the protection of objects from them. Every year, even new bright buildings are destroyed by wind, earthquakes, traffic flows and terrorist attacks, which leads to tens and even hundreds of human victims. In addition, urban residents feel discomfort from transport, industrial and construction seismic.

Such tasks arise not only for designers and builders, creators and engineers responsible for the operation of structures, soil massifs, environments and machines. But also in front of scientists, developers of new standards and software systems.

In this report the author develops and summarizes ideas presented by him in his dissertations on the dynamics of freight cars (1978), buildings and structures (1998), and works [1−3], as well as his colleagues in their doctoral and PhD theses on the dynamics of various real structures and objects. These are V. Banakh (dynamics of the urban environment with complex foundations), V. Redchenko (dynamic tests of bridges), I. Davydov (structures with moving loads), V. Chaban (suspended structures, nonlinearities and flexible threads), D. Yaroshenko (development theory of damping devices and patents for dynamic vibration dampers), A. Makarov (dynamic diagnostics of loading cranes up to 150 m long), A. Banakh (strength and vibration comfort, buildings on subsiding soils), A. Maslovsky (nonlinear dry friction dampers) and others.

Purpose of research. Most of the declared 12 thematic areas of the conference (on innovative technologies in construction and architecture, civil engineering) are analyzed in the report from the standpoint of their links with dynamics. On the one hand, it is necessary to find out whether the new regulatory materials take into account some of the features of modern facilities and technologies for their construction and operation, new variants of dynamic loads, impacts and their combinations? On the other hand, maybe there are new and not yet taken into account possibilities of non-standard dynamic technologies with a broader view (engineering, educational and investment) on the dynamics of objects?

Main results. It is difficult to divide in terms of which questions of the 12 declared topics belong to 1 direction, and which ones do not. This report is, perhaps, all based on theory (topics 1 and 8), but all our decisions (possibly, except for 4 and 11) were brought to practical. Without a doubt, dynamic characteristics and calculations are inevitable in future studies of both renewable energy sources (this is already being successfully dealt with, for example, by VORTEX), and energy-efficient structures – topics 6, 7, etc.

We develop and implement **dynamic shaping methods** (DSM), which allows you to take a broader look at pre-project layouts and design (topic 3). And use not only a qualitative analysis of the composition of object, but also quantitative indicators of natural frequencies (see Monument to Cosmonautics in Dnipro, ISO recommendations for tall buildings with a rectangular plan, etc.).

Many of the designer's problems in the arrangement of masses, stiffnesses, damping devices (along the branches and floors of the structure) are simplified when working with the **dynamic construction method** (DCM) − in the design of linear and nonlinear subsystems (topic 10). Finally, Topics 9 and 10 on the dynamic diagnostics method (DDM) offer dynamic passports, accelerated damage search, etc. new technologies.

By the way, these technologies are very harmoniously combined with "green building" (topic 5 of the conference), comfort (topic 7) and vibroecology (topic 12) of buildings and structures. The author and Prof. M. Kazakevitch (Dusseldorf, Germany) in 1996 published the first edition of the book on this topic in small circulation [1], and now we are working on the second edition with very important additions. Perhaps, this topic of vibration comfort, as one of the most important indicators of life in the 21st century, will be partly more widely covered soon in Kharkiv, at the next NADU conference on environmental aspects in education: "Environmentally oriented higher education. Methodology and practice – 2021". Although in such a topic the road institute "cannot avoid" a discussion of the theory of safe static-dynamic interaction of structures with vehicles with their various parameters and modes of movement. Note that similar work in Poland was carried out long time ago in Krakow under the guidance of prof. Roman Chizhelsky.

Conclusions. The importance of work on improving the safety of modern facilities, on early dynamic diagnostics and pre-emergency detection of structural damage is indisputable. Therefore, in order to significantly improve the quality of technical education in educational institutions and, as a result, increase motivation and professionalism, we consider it necessary to recommend the creation of a wide network of laboratory that studies the dynamics of constructions and structures (**Laboratories Dynamics of Constructions,** LDC) of various configurations and types of tasks. Then the engineers will have a better understanding of the tasks not only of dynamics, but also of statics. It is very useful for a designer not only to draw an idea and drawings of an object, but also to create its layout, and then a computer static-dynamic computational (movable, interactive) model! And, if his results of manual and computer counting turn out to be close to the experimental data on the model, then in this case the knowledge will last for a long time. At enterprises and many factories (such as Engineering plants and design bureaus), in universities, colleges, and schools, the level of knowledge of workers, students, scientists and teachers will rise from the participation of young people in experiments. We, of course, will be happy to share our experience, advise and cooperate, and provide methodological assistance.

Author's video lectures on the basics of the dynamics of structures (8 lectures-conversations) are posted in the public domain on the PSACEA YouTube channel in 2021. Detailed materials and links on defended dissertations on the nonlinear dynamics of doctoral of science (3) and Ph D (6) from circle "Resonance" is available on Facebook on the page of the general education group "Dynamics of structures and the circle "Resonance". The last of them (report and video presentation) were published by the author at the joint (WCCM World and ECCOMAS European) Congress on Computer Mechanics, Paris-2020-2021 [3].

References

1. Kazakevitch M.I. and Kulyabko V.V. *Vvedeniye v vibroekologiyu zdaniy i sooruzheniy* [Introduction to vibroecology of buildings and structures]. Dnipro : PSACEA, 1996, 200 p. (in Russian).

2. Kulyabko V.V. Dynamics of structures – past, present and future (Part 1). Saarbrucen : LAP : LAMBERT Academic Publishing, 2014, 163 p.

3. Vladymyr Kulyabko. Nonlinear dynamics of structures: projects, tests, damping, damages and their diagnostics. 14th WCCM & ECCOMAS Congress Paris−2020, Virtual Congress 11−15 January, 2021, vol. 900, MS256, p. 2663. Barcelona, Spain : International Centre for Numerical Methods in Engineering (CIMNE). ISBN: 978-84-121101-7-3.