DOI https://doi.org/10.30525/978-9934-588-79-2-2.31

THE APPLICABILITY OF TOPOLOGICAL MODELS IN THE STUDY OF FEATURES OF BEHAVIOR OF DISPERSE SYSTEMS AND BUILDING COMPOSITES BASED ON THEM

Trofimova L. E.
Candidate of Technical Sciences, Associate Professor,
Associate Professor at the Department of Technology of Building Production
Odessa State Academy of Civil Engineering and Architecture
Odesa, Ukraine

In terms of synergetics, dispersed building composites are construed as complex nonequilibrium physicochemical systems, the development of which is accompanied by self-organization of dissipative structures [1]. Therefore, to identify the common patterns of behavior of such systems, it is proposed to use a topological approach based on the possibility of modeling of transition of smooth quantitative changes to radical qualitative changes, catastrophe theory [2].

Based on the analysis of numerous experimental results, a similarity of anomalous *S*- and *N*-shaped rheological, kinetic, and other graphical dependencies representing step-like phenomena in various systems and standard curves of stationary states was revealed. As is known, the concept of the multiplicity (nonuniqueness) of stationary states and their instability as a potential source of evolution of systems being far from thermodynamic equilibrium (when nonlinear effects occur) underlies P. Glansdorff's and I. Prigozhin's nonlinear thermodynamics [3]. A change in the number of stationary states with a simultaneous change in the type of stability occurs at bifurcation values of the control parameter, which correspond to kinks of the *S*-shaped curve of stationary states; it is the multiplicity of stationary states that determines the hysteresis effects. Hysteresis is one of the main qualitative features of the catastrophe «ruffle» («cusp»), which is widely used in modeling various phenomena. The presence of hysteresis loops on S-anomalous rheological graphical dependencies made it possible to apply a topological approach to simulate the general picture of processes occurring in disperse systems when external force fields are applied. It should be noted that in the case of *N*-shaped kinks on the graphs, a catastrophe of the type «fold» is applicable.

In the framework of the proposed approach, the experimental dependences revealed the representation of two main directions connecting the geometry of catastrophes of the type «ruffle» with the system under study (maximum delay principle and Maxwell's principle). The choice of a specific principle is determined by the nature of the phenomenon itself.

It is proposed to consider the standard *S*-shape as the most adequate model of the real picture of the loss of the initial flow stability and transition to a new stable course regime. The model «ruffle» (the principle of maximum delay) describes the evolution of the effect of *S*-anomaly of the dispersion course during shear, which makes it possible to identify the most significant features of the appearance of zones of increased density and the formation of discontinuities of continuity. It was also established that such a model representation clearly illustrates the experimental effects being observed when a vibration with optimal parameters is applied to a deformable system. In a generalized schematic form, it has been demonstrated that the features of the behavior of dispersions under conditions of a combination of continuous shear with vibration being orthogonally directed towards it (in accordance with [4]) contribute to the formation of a set structure of the composite material, which determines its operational indicators.

The model «ruffle», the geometry of which obeys the Maxwell's principle, describes the effect of a continuum violation in changing the linear velocity along the cross section of the clearance between the coaxial cylinders of a rotational viscometer when a certain critical velocity of dispersion deformation is exceeded. In this situation, the geometry of the model is similar to the configuration of the so-called shock wave, for which steep profile drops are typical [1, 4].

It should be noted that catastrophe theory may also be applied in the study of various anomalous effects characteristic not only of technological processes for the formation of various composites, but also for operational practice. In particular, it was proposed to use a topological approach to describe some aspects of the mechanochemical effect of the sign of deformation in stress corrosion phenomena.

It is proposed to describe and analyze the curves of temperature deformations of dry and wet fine-grained concrete which has *N*-shaped kinks using a model «fold». The results of the study of the influence of the percentage of reinforcement on the temperature deformation of reinforced concrete are also illustrative from the standpoint of the approach involved.

The applicability of the topological approach in the study of the anomalous behavior of the isotherms of water desorption of cement stone, cement-sand mortar, asbestos cement, calcium hydrosilicates C-S-H in a

certain region of relative vapor pressure is shown. It is proposed to interpret the transformation of desorption isotherms with the growth of the C/S model «ruffle» (Maxwell's principle). Such a model representation combines individual nontrivial experimental effects into a certain fundamental regularity.

Thus, the involvement of a topological approach opens up new possibilities in modeling real situations with sudden catastrophic rearrangements of regimes in developing dynamic systems.

References:

1. Николис Г., Пригожин И. Самоорганизация в неравновесных системах. М. : Мир, 1979. 512 с.
2. Трофимова Л.Е., Урьев Н.Б. Моделирование процессов структурообразования дисперсных систем и материалов. Одесса : Астропринт, 2011. 36 с.
3. Гленсдорф П., Пригожин И. Термодинамическая теория структуры, устойчивости и флуктуаций. М.: Мир, 1973. 280 с.
4. Урьев Н.Б. Высококонцентрированные дисперсные системы и материалы. М. : Техполиграфцентр, 2018. 407 с.

DOI https://doi.org/10.30525/978-9934-588-79-2-2.32

ОБҐРУНТУВАННЯ РІВНІВ ОБСЛУГОВУВАННЯ ПРИ ЕКСПЛУАТАЦІЙНОМУ УТРИМАННІ АВТОМОБІЛЬНИХ ДОРІГ

Харченко А. М.
кандидат технічних наук, доцент,
доцент кафедри транспортного будівництва та управління майном
Національного транспортного університету
м. Київ, Україна

Пріоритетними питаннями щодо експлуатаційного утримання автомобільних доріг в Україні є обґрунтування раціональних рівнів їх обслуговування, що впливатимуть на:

– підвищення безпеки дорожнього руху;
– збереження складових автомобільних доріг;