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ANALYSIS OF FRAME STRUCTURES BASED ON BIM TECHNOLOGIES IN THE LIRA-SAPR ENVIRONMENT

The modern development of the construction industry is accompanied by the active implementation of digital technologies, among which Building Information Modeling (BIM) occupies a leading position. This approach ensures the creation of a unified digital model of a construction object that integrates geometric, physical, mechanical, and operational characteristics of structural elements and is used throughout all stages of the structure's life cycle.

From the perspective of structural mechanics, the implementation of BIM technologies enables a fundamental transformation of approaches to the development of computational models and the analysis of the stress–strain state of structures. This is particularly relevant for frame buildings, which are characterized by complex spatial behavior of elements, a significant number of nodal connections, and interaction between load-bearing systems.

The aim of this study is to investigate the features of frame building analysis using BIM technologies in the LIRA-SAPR environment [1] and to evaluate the effectiveness of an integrated approach in structural mechanics problems.

In this context, it is appropriate to draw attention to the practice of implementing frame and modular buildings in Ukraine, in particular the activities of the company T-Modul (Poltava) [2], which specializes in the development of modern modular-frame houses based on engineering-grounded solutions, eco-friendly materials, and principles of energy efficiency. Such an approach provides a practical basis for the application of BIM technologies in the design and analysis of frame structural systems.

Frame buildings are considered spatial systems composed of bar elements connected through joints of varying stiffness. Their analysis requires consideration of the combined behavior of all components forming the load-bearing system. In this regard, the correct definition of boundary conditions, material properties, and load combinations plays a crucial role. The LIRA-SAPR software (Fig.1) environment provides the capability to model complex spatial systems taking into account both physical and geometric nonlinearity, allowing for a more accurate representation of the real structural behavior. When modeling a frame building designed according to modular construction principles, it was taken into account that wall and floor elements have a multilayer structure with thermal insulation (for example, basalt wool with a density of approximately 45 kg/m^3). This introduces additional spatial stiffness, which is not always considered in simplified computational schemes. During the

analysis in LIRA-SAPR, it was found that accounting for enclosing structures as partially contributing elements leads to a reduction in horizontal displacements of the building by 10 – 18%. This is a significant result demonstrating the importance of integrating BIM models without excessive simplification.

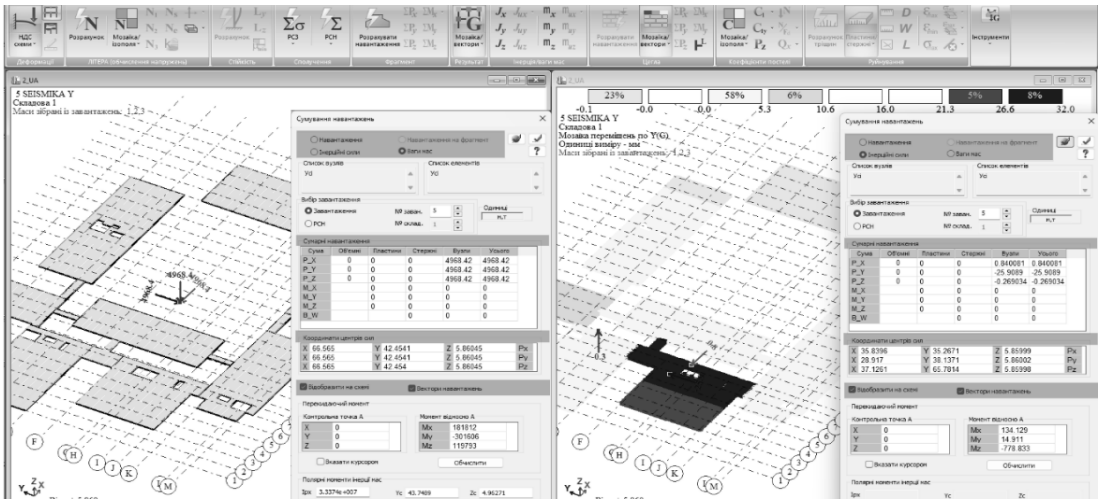

Fig. 1 – User interface of the LIRA-SAPR environment

The obtained results indicate that the use of BIM technologies in combination with LIRA-SAPR is particularly effective for modular-frame buildings. The high geometric accuracy and standardization of structural elements characteristic of such systems allow for the full realization of the potential of numerical modeling.

As a result of the conducted study, it has been established that the use of BIM technologies combined with the finite element method is an effective tool for the analysis of frame buildings. The application of the LIRA-SAPR software package ensures high accuracy of engineering analysis and optimization of structural solutions. The integration of information modeling and computational methods forms a new level of design organization that meets modern requirements of the construction industry.

In addition, the concept of “growing housing”, which provides for the possibility of step-by-step building expansion through the addition of new modules, poses new challenges for structural mechanics, particularly in terms of analyzing structural behavior under changing configurations. This opens up prospects for further research in the field of adaptive computational models.

Literature:

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