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ALGORITHMIZATION OF SCIENTIFIC RESEARCH RESULTS IN CONSTRUCTION INDUSTRY PROBLEMS

In the current context of construction industry development, the effective implementation of scientific research results into practice is becoming increasingly important. One of the ways to integrate scientific knowledge into engineering processes is algorithmization – the formalization of tasks into logically structured procedures or numerical models suitable for automated analysis. In this context, software systems such as LIRA-SAPR and Building Information Modeling (BIM) technologies play a special role [1].

The LIRA-SAPR software suite is widely used in the field of structural calculation and design [2,3]. Its mathematical core is based on the finite element method (FEM), which enables the creation of highly accurate numerical models of structures of various complexity levels. To implement algorithmization in LIRA-SAPR, it is necessary to clearly define the geometric scheme of the structure, material properties, boundary conditions, load types, and interaction scenarios of structural elements. This process forms a solution algorithm that the software executes automatically based on the provided input data.

Scientific research related to the strength of new materials, the impact of loads, temperature effects, or seismic activity can be integrated into LIRA-SAPR models as variables or conditions. For example, results from laboratory tests of fiber-reinforced concrete or lightweight concretes with recycled aggregates can be used to calculate the load-bearing capacity of floor slabs in building renovations. Thus, the algorithm for transforming scientific data into project calculations is practically implemented.

The algorithmic approach is especially effective when solving nonlinear modeling problems that take into account material plasticity, contact interactions, and stiffness changes during deformation. This allows for accurate prediction of structural behavior under emergency loads or extreme conditions, which is highly relevant in the post-war reconstruction of Ukraine's infrastructure.

Special attention should be given to the integration of LIRA-SAPR capabilities with BIM technologies, which elevates algorithmization to a new level. BIM is not only a graphical representation of a building but a comprehensive digital platform that includes information on all elements, their properties, costs, installation timelines, and operational characteristics. Thanks to software compatibility and file exchange, engineering calculations performed in LIRA-SAPR can be imported into BIM models, where research results become part of an integrated digital facility management system.

For instance, when designing frame structures in seismic regions, a model can be created in a BIM environment (such as Revit [4] or Allplan) and then exported to LIRA-SAPR (Fig.1) for detailed seismic analysis, accounting for local soil characteristics and spectral features of disturbances. The analysis results are returned to the BIM model, where structural parameters are automatically updated. This ensures a closed-loop algorithmization process that includes research, design, modeling, analysis, and decision-making.

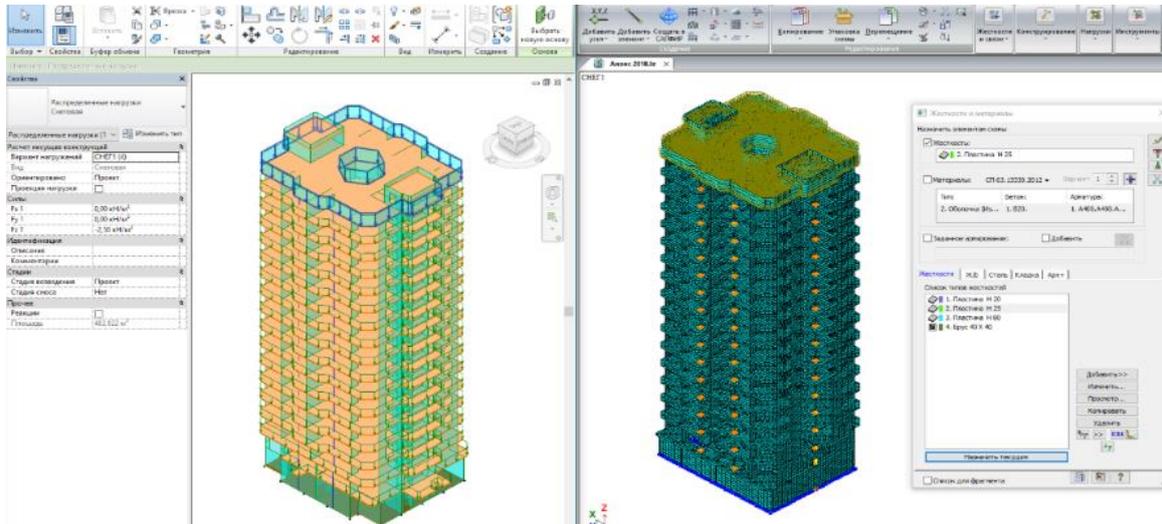


Fig. 1. Model in the Revit BIM environment and in LIRA-SAPR

Such approaches ensure high adaptability of the developed systems, allow for the design of complex objects considering environmental changes, reduce costs, and shorten construction timelines. Algorithmic thinking and digital integration also contribute to process transparency, simplify project expertise, and quality control.

Modern construction education should actively incorporate algorithmization approaches through the use of LIRA-SAPR and BIM. The development of structured thinking skills, the ability to create computational algorithms, and the evaluation of solution options in a digital environment are key competencies for the 21st-century engineer. Algorithmization of scientific research results using LIRA-SAPR and BIM technologies ensures an effective link between science and practice. It opens up new opportunities for adapting structural models to real conditions and improving the precision and speed of design decisions.

References:

1. Chaika Y.I., Hutnik O.O. Implementation of BIM modeling technologies in the educational process // *Scientific Bulletin of Construction*. – 2021. – Vol. 106, No. 4. – P. 162–167.
2. Verbytskyi K., Bezbabycheva O. From the experience of using the LIRA-SAPR software in practical lessons on strength of materials // *Proceedings of MCND Conferences*. – Sumy, Ukraine. – P. 162–167.
3. <https://www.liraland.ua/>
4. <https://www.autodesk.com/products/revit/overview>