# The role of digital technologies in the formation of specialists training in construction

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**Abstract.** Media space and digital technologies occupy ever increasing area in everyday life, including design and construction of engineering structures of various purposes. Training of future specialists specializing in construction is not an exclusion. Nowadays education involves elements of real design and construction activity, such as using modern software complexes in education, which allow to study future specialty at early stage. Thus, it is possible to form required competences of future specialists for their further activity. This article analyzes experience of teaching digital technologies exemplified by the use of modern software complex: LIRA-SAPR (OOO LIRA-SAPR, Kiev).
**Keywords:** software, finite element method, digital education technologies.

## 1 Introduction

At present, digital education technologies play great role in learning process. Nowadays the requirements not only to knowledge of basic aspects of construction are applied to the graduates specializing in construction but also to rapid and high-quality skills to plot drawings using computer graphics by Autodesk software: AutoCAD, Revit, Russian product: nanoCAD, as well as to computations of complex structures of buildings and facilities using modern CAD systems [1, 2].

## 2 Methods

LIRA-SAPR software based on finite element method (OOO LIRA-SAPR, Kiev) is one of the computational complexes widely used in Russia and CIS countries [3, 4]. The developer of this software presented full professional version for studying purposes; thus, it is possible to provide high-quality training of students in simulation of structures of various degrees of complexity and implementation of the required computations. Analysis of LIRA-SAPR software is carried out during training of bachelors and masters specialized in Construction, as well as engineers specialized in Construction of unique buildings and facilities.

At initial stages of training, plane and spatial rod structures are considered, followed by board structures of various purposes and various buildings and facilities. The impact of static

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and dynamic loads on these structures is analyzed, such as own weight, operation loads, snow, wind and other loads. Herewith, upon consideration of wind loads, two variants of their application are accounted: wind load with accounting for dynamic impact of wind pulsation, or wind load considered as quasistatic, when the dynamic impact of wind pulsation is reduced to respective static load. In addition, the building features and results of seismic load of various intensity are considered. Using LIRA-SAPR software, students specializing in Industrial and civil construction, Expertise and management of real estate, and Construction of unique buildings and facilities are trained in optimum design of structures [5-9] and in predictions for progressing destruction of buildings. Studying the publications on this topic is also performed [10-13].

While simulating structures and facilities, the variants of boundary conditions are considered as ideal, when a building is supported by nondeformed base. The real conditions of supporting by ground multilayer base, probably under conditions of watering of certain layers of the base, are also considered (Figure 1). LIRA-SAPR implements the model of ground base with two coefficients of bed by Prof. P.L. Pasternak. While predicting the model of ground base, it is possible to estimate the influence of closely located buildings and facilities on the developed object. In addition, if required, it is possible to develop structures on ground base by Fuss-Winkler model.

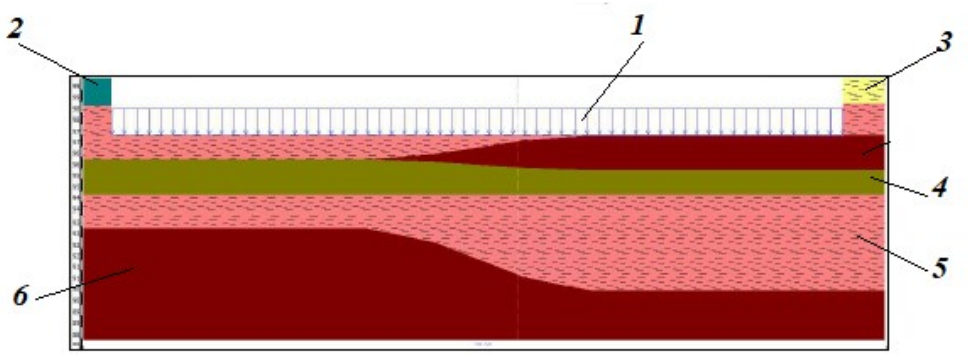


**Fig. 1.** Cross section along building support by ground base: 1 – building load on ground; 2 – filled soil; 3 – water saturated dusty sand; 4 – low plasticity clay loam; 5 – water saturated sand clay; 6 – semihard clay.

At present, LIRA-SAPR software is equipped with preprocessor: SAPFIR-KONSTRUKTSII software, which is very important for students specializing in Industrial and civil construction, Expertise and management of real estate, and Construction of unique buildings and facilities. Initially SAPFIR-KONSTRUKTSII software forms architectural building model of any complexity. Then, on the basis the architectural model, an analytical building model is obtained, which is accompanied by analysis of accuracy of the architectural model in terms of future finite element predictions, and a prototype of finite element grid for overall building is formed. Then, the analytical model is exported into LIRA-SAPR software, where it is transformed into finite element model, then the required reinforcement is determined and calculated. After calculations in LIRA-SAPR the resulted reinforcement is transferred into SAPFIR-KONSTRUKTSII, and on this basis, the software creates prototypes of engineering drawings with ready reinforcement layout.

Graduate students as well as future engineers specializing in Construction of unique buildings and facilities master the development of building structures with accounting for nonlinear work [13-15] during studies. They learn the peculiarities of simulation and design of structures of buildings and facilities with accounting for physical nonlinearity of work of reinforced concrete, geometric nonlinearity of ideal cable, perform calculations with

accounting for structural nonlinearity occurring as a result of variation in designed scheme during operation loading of structure.

## 3 Results

The results of training using digital technologies are exemplified by graduate qualification works and diplomas by means of LIRA-SAPR software. In general, students show high interest and express positive attitude to learning the design of structures of buildings and facilities using modern software. Therefore, about 70–80% of graduates execute their qualification works using software. Figure 2 illustrates a finite element model of building developed in graduate work of bachelor specializing in Construction.

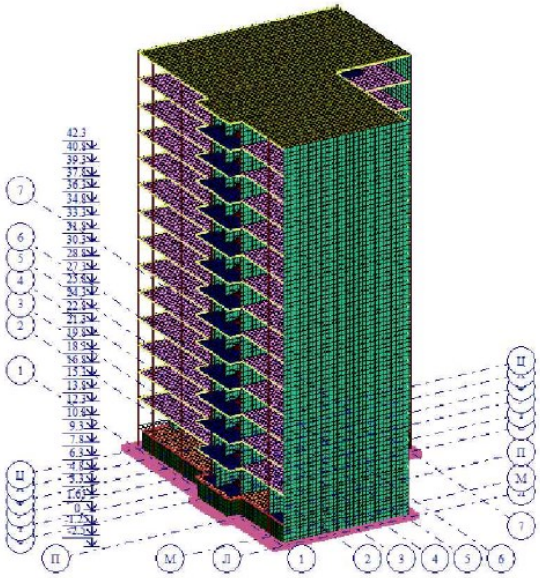

**Fig. 2.** Finite element model of building in LIRA-SAPR 2019 software

## 4 Discussion

The use of modern CAD software during training of students specializing in construction allows to learn real designing at early stages; execution of tests in the form of graphical calculations and diploma projects promotes accumulation of experience of future work. In addition, this promotes studying of regulatory and specialized sources.

## 5 Conclusion

Training in media space using digital technologies during simulation of real design of buildings and structures forms the required competences in students specializing in construction; these competences allow to search and to analyze necessary information, to determine problems while achieving the formulated target, to independently design building structures using modern software. All this promotes students' training for future activity.

## References

1. A.S. Gorodetskiy, M.S. Barabash, V.N. Sidorov, Komp'yuternoye modelirovaniye v zadachakh stroitel'noy mekhaniki [Computer modeling in problems of structural mechanics] (Izdatelstvo ASV, Moscow, 2016)
2. A.V. Perelmuter, V.I. Slivker, Raschetnyye modeli sooruzheniy i vozmozhnost' ikh analiza [Design models of structures and the possibility of their analysis] (DMK-Press, Moscow, 2007)
3. S.I. Trushin, Stroitel'naya mekhanika. Metod konechnykh elementov [Structural mechanics. Finite Element Method] (INFRA-M, Moscow, 2018)
4. I.N. Serpik, Metod konechnykh elementov v reshenii zadach mekhaniki nesushchikh sistem [The finite element method in solving problems of the mechanics of bearing systems] (Izdatelstvo ASV, Moscow, 2015)
5. A.P. Denisova, S.A. Rashchepkina, Methods of optimal design of building structures:study guide (Izdatelstvo ASV, Moscow, 2012)
6. M.N. Kirsanov, Magazine of Civil Engineering, **64(4)**, 52–58 (2016). https://doi.org/10.5862/mce.64.5
7. A.V. Alekseytsev, N.S. Kurchenko, Magazine of Civil Engineering, **73(5)**, 3–13 (2017). https://doi.org/10.18720/MCE.73.1
8. I.N. Serpik, A.V. Alekseytsev, P. Yu. Balabin, N.S. Kurchenko, Magazine of Civil Engineering, **76(8)**, 182–192 (2017). https://doi.org/10.18720/MCE.76.16
9. S.V. Klyuev, D.I. Shlychkov, K.A. Muravyov, T.K. Ksenofontova, International Journal of Advanced Science and Technology, **29(5)**, 2577–2583 (2020)
10. V.O. Almazov, Prevention of progressive destruction (MGSU, ISA, Moscow, 2006)
11. Standardinform , SP 385.1325800.2018. Protection of buildings and structures against progressive collapse. Design code. Basic statements (Standardinform, Moscow, 2018). Accessed on: December 20, 2020. [Online]. Available: http://docs.cntd.ru/document/551394640
12. Standardinform, SP 296.1325800.2017. Buildings and structures. Accidental actions (Standardinform, Moscow, 2017). Accessed on: December 20, 2020. [Online]. Available: http://docs.cntd.ru/document/555600219
13. T.K. Ksenofontova, Lecture Notes in Civil Engineering, **95**, 73–78 (Springer, Cham, 2020). https://doi.org/10.1007/978-3-030-54652-6_11
14. V.I. Kolchunov, N.B. Androsova, N.V. Klyuyeva, A.S. Bukhtiyarova, Zhivuchest' zdaniy i sooruzheniy pri zaproyektnykh vozdeystviyakh [Survivability of buildings and structures under non-design impacts] (Izdatelstvo ASV, Moscow, 2014)
15. A.G. Tamrazyan, Housing construction, **1(12)**, 15–18 (2010)