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***Research paper***

# Usage of the Floor-Lifting Method for Buildings Erection with Precast-Monolithic Reinforced Concrete Frames of «KUB» or Similar Frame Systems

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**Abstract**

Usage of the floor-lifting method for buildings erection with precast-monolithic reinforced concrete frames of «KUB» or similar frame system was reviewed in the article. Analysis of technological features of proposed method was done. Advantages and disadvantages of proposed method usage were listed. Opportunity of floor-lifting method of reinforced concrete frames buildings erection in dense areas usage was justified. Usage of the floor-lifting method for erection of buildings with precast-monolithic reinforced concrete frames of «KUB» or similar frame system allows to reduce the works complexity due to the complete refusal to use the equipment for the verification and temporary fixing of slabs individual elements and the operations exclusion associated with the retrieval and temporary fixing floor slabs elements. Proposed method usage allows to move majority of assembly operations to the ground floor level, which can significantly increase the industrial safety level, improve the work and control quality. Reducing the installation parameters values, allows to use less powerful self-propelled cranes for building frame elements installation, in some cases, completely refuse to use the tower cranes. It makes sense to use this building frameworks erection method in dense urban areas. The main disadvantage of this method is the high demanding quality of the slabs elements production. Because the surface of the slab is the basis for the next floor slab, inaccurate factory production will not allow the exact slabs elements installation in the required position.

***Keywords***: *Floor lifting method, "KUB" system, precast-monolithic frames.*

## 1. Introduction

In the last decades of the XX century and at the beginning of this century, housing construction with the use of precast-monolithic frame system "KUB" and related systems has become widespread [1, 2, 3]. Residential complexes and districts are being built using this constructive system (figure 1).

Advantages of such systems include: wide possibilities for designing, free planning and redevelopment of premises, high unification of elements, resistance to seismic influences, the possibility of buildings erection ace up to 24 floors, construction speed and other [4]. However, along with the advantages, these systems also have disadvantages, among them the complexity and high laboriousness of installation, verification and temporary fixing of structural elements of the ceiling before the joints filling [5]. The complexity of the verification and temporary fixing of the ceiling leads to inaccuracies in the installation in the horizontal and vertical direction, which entails the need for additional technological operations, additional time expenditures. Reducing the complexity and laboriousness in the construction industry is actual because of tight competition among construction companies.



**Fig. 1**: Residential complexes built with the usage of precast-monolithic frame structures of the "KUB" system

## 2. Analysis of recent research and publications

Taking into account the high demand on the housing market for monolithic frameworks "KUB" and related systems, a large number of scientific research was carried out over the last decades and many scientific papers were published. A large number of different issues were investigated [6, 7, 8]. Problems of structural

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elements and joints design [3], seismic impact assessments [3], and various planning solutions [9] were solved. Various equipment for checking and ceiling elements temporary fastening, which considerably improves the accuracy of structures installation, is offered.

### 2.1. The purpose of the paper

An analysis of the floor lifting method usage for the residential buildings erection with a "KUB" precast-monolithic frame system and other related systems are given in the paper. Coverage of the floor lifting method usage advantages and disadvantages for the such type buildings construction are showed. Possibility analysis of the proposed method buildings construction in conditions of dense urban area were under investigation in the paper.

### 2.2. Formulation of previously unresolved issues of a common problem.

Through the research conducted in recent years, the overwhelming number of issues concerning the design and calculation problems of the constructive specified type systems were solved. However, from the construction technology point of view the frameworks usage, which are under consideration, not all issues have yet been resolved. One of these issues is the exclusion of the need to use additional equipment for verification and temporarily fastening of elements and, as a consequence, the exclusion of technological operations related to the verification and fixing, reducing complexity of the frame construction, increasing the level of industrial safety during the execution of installation works.

## 3. Basic material and results

The specified frame system type consists of the elements depicted in Figure 2.

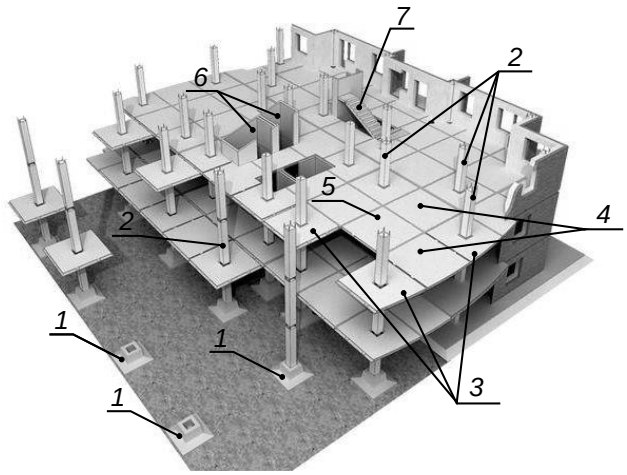



**Fig. 2:** Precast-monolithic frame of "KUB" system: 1 – foundations; 2 – columns; 3 – columns slabs; 4 – slabs, placed between columns; 5 – middle slabs; 6 – elevator shafts; 7 – stair cells

The frame erection is executed in the following sequence [4, 5, 8]: 1 – installation of foundations; 2 – installation of columns; 3 – installation, verification, temporarily fixation with the conductors of columns slabs; 4 – installation, verification, temporarily fixation with the mounting supports of slabs, placed between columns; 5 – similar installation of middle slabs; 6 – installation and welding of metal elements of joints; 7 – execution of joins concrete filling; 8 – removing of mounting supports and conductors.



**Fig. 3:** The process of columns slabs installation

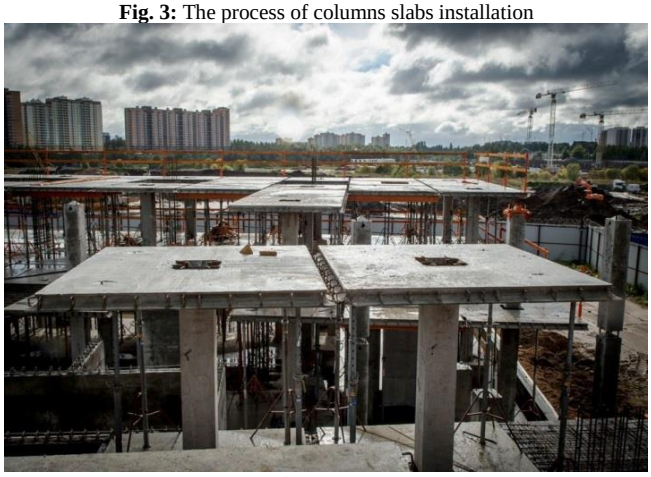


**Fig. 4:** Installed, verified and temporarily fixed slabs

During the installation of the ceiling elements and their verification, three install-workers are on the slab with an area not less than 4 $m^2$, which does not have a fence. It can lead to falls from heights, falling of tools and equipment.

Temporary fastening and checking is carried out with the help of mounting supports. To fix one slab, four supports are used. It is necessary to install about 500 temporary supports for the construction of a 500 $m^2$ ceiling. After filling and solidifying the concrete in the joints, all these supports must be dismantled and moved to the next floor. The labor complexity of works related to the temporary fixing of ceiling elements is up to 50% of the total labor complexity of ceiling construction.

The solution to these issues is an important task as in terms of labor protection improving and in terms of a significant reduction of labor complexity and increasing cost-effectiveness.

One of the methods for the construction of framed buildings with a monolithic or prefabricated monolithic frame is a method of floor lifting (Figure 5). The sequence of a frame construction in this way consists of the following operations: 1 – installation of foundations; 2 – installation or creation of first level columns; 3 – erection of underground building part; 4 – creation of monolithic ceiling above the building underground part; 5 – arrangement of the entire floor slabs package from the first to the last floor over the basement, distribution layer arrangement. Plates are separated by a separating layer. Each next slab created after the concrete of previous slab has reached of required strength. 6 – installation on the first level columns the lifts for slabs lifting, the slabs are raised to an intermediate position and fixed. 7 – concreting of the second level of columns or installation of columns; 8 – the rising of the slabs continues after the column`s concrete has reached of required strength. The last two items are repeated before finishing of the concreting or column`s last level installation and the all slabs lifting in the project position.

The method described above was used in building practice for the construction of residential and public buildings frameworks exclusively with monolithic slabs. This method allows to shorten significantly the usage period of building cranes, and sometimes completely abandon of their use, significantly reduce the construction site area.

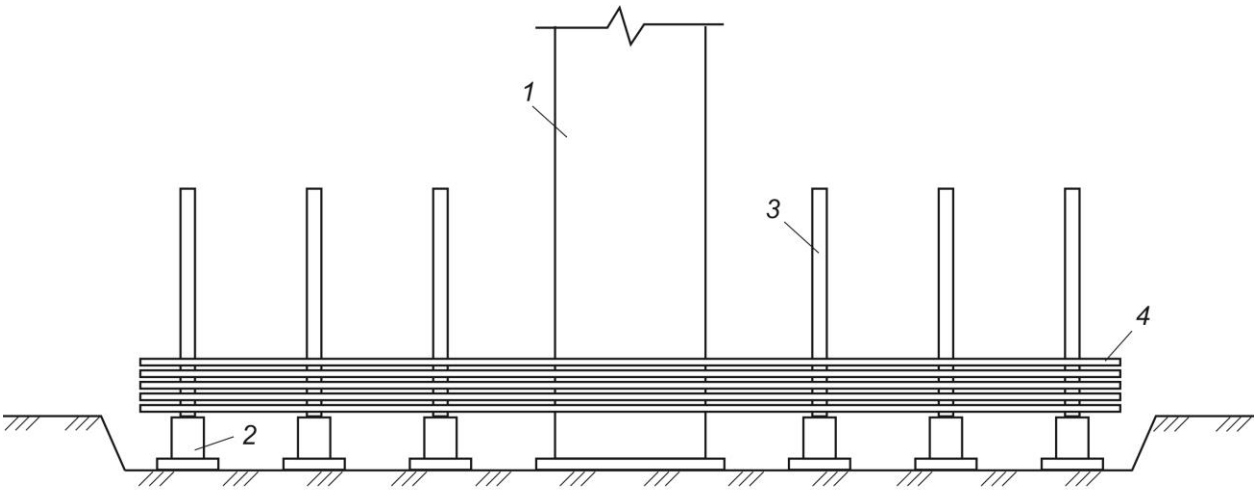



**Fig. 5:** Construction of building with the floor lifting method usage: 1 – core of rigidity; 2 – foundations; 3 – columns; 4 – package of slabs

If we analyze the key features of this frame construction method, it becomes obvious that it can be applied with certain changes to the construction of frames considered in this paper. The process of a frame erection will have the following structure: 1 – creation of foundations; 2 – creation of first level columns; 3 – construction of building underground part; 4 – installation of building underground part slabs with traditional methods; 5 – checking the horizontality surface of slabs, if it is necessary, surface leveling; 6 – installing the elements of the next level slab on the floor slab surface above the underground part; 7 – installation and welding of metal joints elements; 8 – filling of joints with concrete; 9 – after reaching the concrete in joints of required strength, operations 7 and 8 are repeated for other levels floor slabs (Figure 6); 10 – on the first level columns installed lifts for slabs lifting, the slabs are raised to an intermediate position and fixed (figure 7); 11 – concreting of the second level of columns or installation of columns; 12 – the rising of the slabs continues after the concrete of columns has reached of required strength. The last two items are repeated before finishing of the concreting or installation of the last level columns and the lifting of all slabs in the project position.

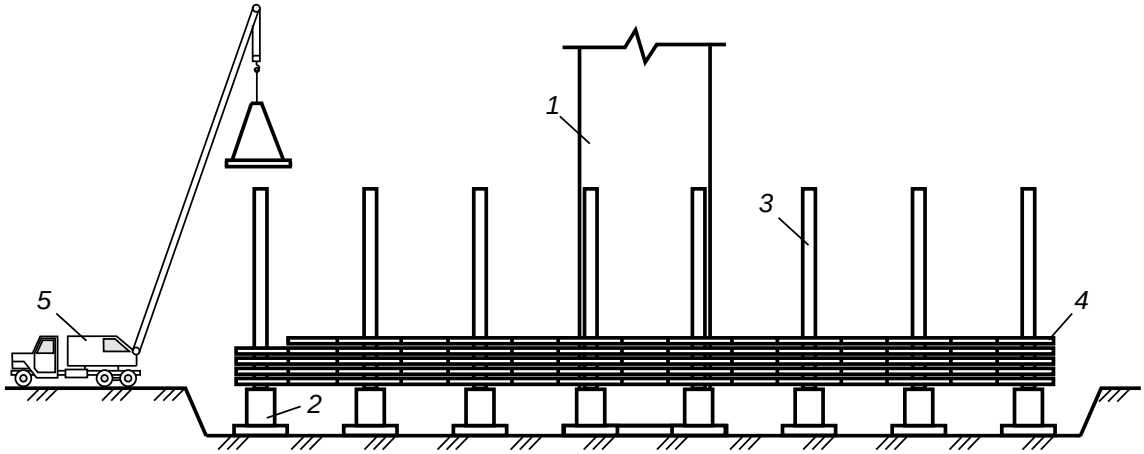



**Fig. 6**: Creation of slabs package: 1 – core of rigidity; 2 – foundations; 3 – columns; 4 – package of slabs; 5 – crane.

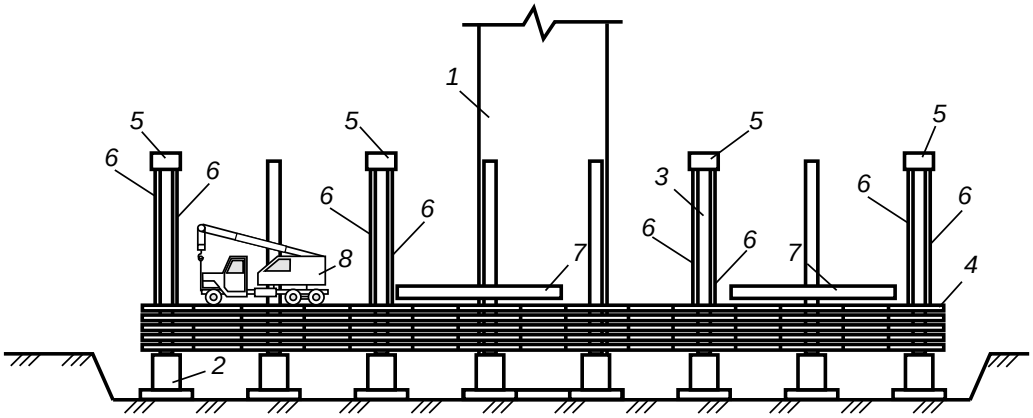



**Fig. 7**: Lifting of slabs to an intermediate position:1 – core of rigidity; 2 – foundations; 3 – columns; 4 – package of slabs; 5 – lifts; 6 – metal bands 7 – stocked up columns; 8 – building crane

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As can be seen from the above structure installation process of "KUB" system framework or related systems, most of the installation operations are transferred to the ground floor level. It significantly (up to 75%) reduces the duration of install-workers at a height. From the work`s structure excludes operations of temporary fixing and verification of the slabs elements position, it allows to significantly reduce the installation complexity of ceiling elements (up to 30 – 50%). The transfer of majority of installation operations to the ground floor level can significantly improve the work quality, facilitate the quality control implementation. The need of cranes usage, in addition to construction the core of rigidity and building underground part, is maintained during the installation of floor slabs package, the installation of columns and the lifts installation on the columns. The creation of the floor slabs package at the ground floor level allows to refuse the usage of tower cranes. The installation of the columns of the second and the other levels and the reinstallation of the lifts can be carried out with the help of a crane installed on the surface of the upper ceiling slab (Figure 8). The stocking of the columns of the second and next levels takes place on the last floor slab surface.

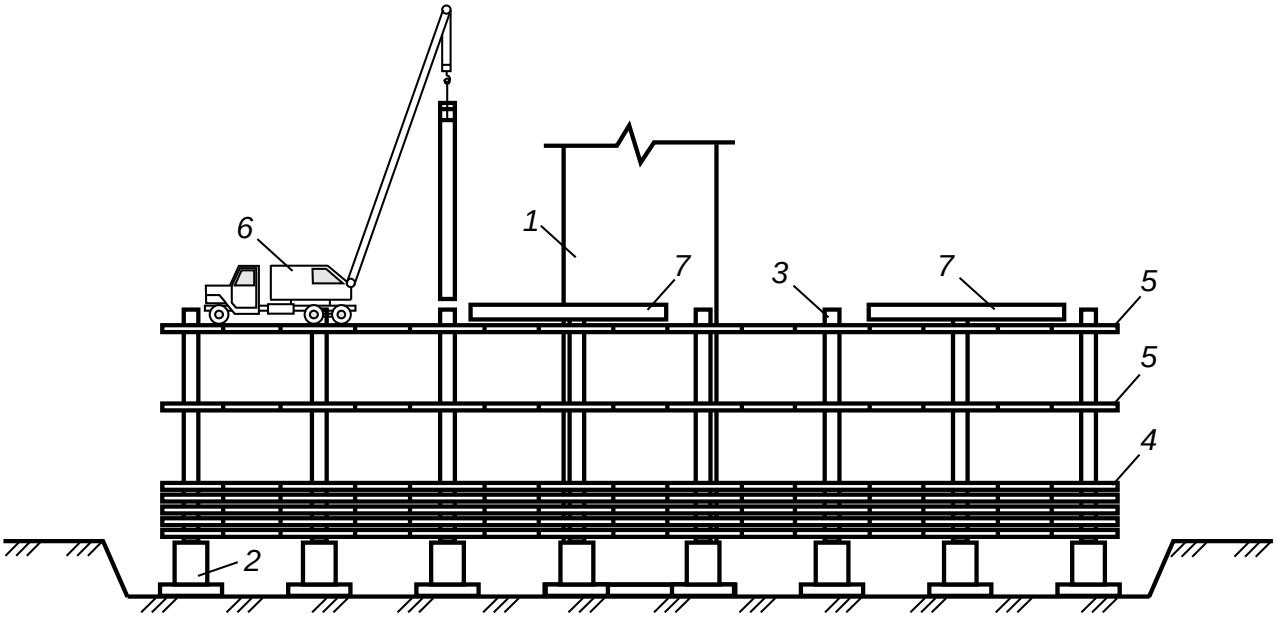



**Fig. 8**: Installation of second level columns: 1 – core of rigidity; 2 – foundations; 3 – columns; 4 –slabs package; 5 – slabs installed to an intermediate position; 6 – crane; 7 – stocked up columns.

## 4. Conclusions

The usage of the floor lifting method for the "KUB" system frames and related systems construction can reduce the work complexity on the floor slabs construction due to the complete refusal of the equipment usage for the verification and temporary fixing of individual floor slabs elements and the exclusion of operations associated with the verification and temporary fastening of floor slabs elements. The usage of the proposed method allows to transfer majority of assembly operations to the ground floor level. It can significantly increase the level of industrial safety, improve the work quality and control quality. Moving the most installation operations to the ground level, installing the columns of the second and next levels from the last slab surface, significantly reduced mounting values, allows to use less powerful self-propelled cranes for the installation of building frame elements, in some cases, to completely abandon of tower cranes usage. It makes sense to use this construction method in dense urban areas. The main disadvantage of the method is the high demand for the quality of floor slabs elements manufacturing. Because the surface of the slab is the basis for the slab of the next floor. Inaccurate factory production will not allow the exact slab elements installation in the required position.

## References

[1] *Deltabeam Composite beam: designer manual*, Peikko group, Canada, (2013), 18 p., available online: http://goo.gl/pNuG5
[2] *Deltabeam Installations Instructions*, Peikko group, Canada, (2009), 8 p. available online: http://goo.gl/EqL8K
[3] Pavlikov AN, Balyasnii DK, Harkava OV, Dovzhenko OO, Mykytenko SM, Pinchuk NM, Fedorov DF, *Modern constructive systems of buildings from reinforced concrete: Monograph*, Poltava: PoltNTU, (2017), 120 p.
[4] Kobzar II, Ostashevska GG, Zolotova NM, *Construction Technology: Tutorial*, Kharkiv, (2011), 171 p.
[5] ZHvan VD, Pomazan MD, ZHvan OV, *Construction and installation of buildings and structures: Tutorial*, Kharkiv, (2011), 396 p.
[6] Pavlikov AN, Krutov VA, Petter BN, "Industrial non-beam frame building systems for residential buildings", *Building Structures*, No. 81, (2014), pp: 286-293, available online: http://nbuv.gov.ua/UJRN/buko_2014_81_36
[7] Pavlikov AN, Zotsenko NL, Vynnykov YuL, "Improved industrial noncapital-nonbeam structural building system for solving the problem of affordable housing in Ukraine", *Proceedings of the Intern. scientific and technical. Conf. "Scientific and technological progress in building and architecture"*, (2014), pp. 145–152.
[8] Firm "KUB", *Unified system of precast-monolithic noncrossbar. Basic provisions for the calculation, installation and layout of buildings: working project: in 9 issues, Journal of Safety Research*, Moscow: Monolith, (1990).
[9] Pavlikov AM, "Implementation of the noncross-beam-noncapitel framework system in the design of buildings for affordable housing", *Resource-saving materials, constructions, buildings and structures*, No. 27, (2013), pp. 352–359.
[10] Zyma OE, Dyachenko EV, Pahomov RI, Zhyhylii SM, "Works execution organization at reconstruction and renovation of buildings after the fire with usage of slabs lifting method", *International Journal of Engineering & Technology*, Vol.7, No 2.23, (2018), pp: 242-246. https://doi.org/10.14419/ijet.v7i2.23.11951
[11] Chichulina K, Chichulin V, "Steel statically uncertain transverse frames probabilistic calculation", International Journal of

Engineering &Technology (IJET)**,** Vol 7, No. 3.2. Special Issue 2, (2018), p. 79-85, available online: https://www.sciencepubco.com/index.php/ijet/article/view/14379/5810

[12] Gasii G, Hasii O, and Zabolotskyi O, "Estimate of technical and economic benefits of a new space composite structure", MATEC Web of Conferences, Vol. 116, (2017), pp. 02014. https://doi.org/10.1051/matecconf/201711602014.

[13] Caldwell M, *The Fort Stanwix Administrative History: A Superintendent's Perspective*, Vol.31, No.2, The Public Historian, (2009).

[14] El Gawady M, Lestuzzi P, Badoux M, "A Review of Conventional Seismic Retrofitting Techniques for URM", *Proceedings of the 13th International Brick and Block Masonry Conference (July 4 - 7)*, Amsterdam, (2004).

[15] Smith A, Redman T, "A Critical Review of Retrofitting Methods for Unreinforced Masonry Strucutres", *Proceedings of the EWB-UK Research Conference*, The Royal Academy of Engineering, London, (2009).

[16] Perelmuter, A. V., & Pichugin, S. F. (2014). Issues on estimation of building structure vulnerability. *Magazine of Civil Engineering*, *49*(5), 5-14+121. https://doi.org/10.5862/MCE.49.1

[17] Leshchenko M. V., Semko V. O. Thermal characteristics of the external walling made of cold-formed steel studs and polystyrene concrete. *Magazine of Civil Engineering*. № 8, (2015), pp. 44–55. https://doi.org/10.5862/MCE.60.6

[18] Semko O., Yurin O., Avramenko Yu., Skliarenko S. Thermophysical aspects of cold roof spaces. *MATEC Web of Conferences*. Vol. 116, (2017), p. 02030. https://doi.org/10.1051/matecconf/201711602030