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STRUCTURAL DESIGN FEATURES OF THE COMMUNITY COMMERCIAL BUILDINGS IN COMPREHENSIVE DEVELOPMENT SYSTEM

Abstract. *The necessity of comprehensive development of the urban residential areas in Ukraine, which is presented as a project management system, presumes the achievement of the strategic objective – improvement of people’s residence comfort by the use of various design solutions for community commercial buildings. The study of the structural organization of public buildings was made to enable the formation of community commercial buildings. The advantages of different architectural structural systems developed in architectural bureaus and research institutes are defined. Based on desk studies and practical research outcomes benefits of diverse structural systems for formation of small cellular units and big show rooms in commercial buildings are identified. The merits of light metal structures are noted, as well as of the architectural structural systems developed on their basis. A new methodology of community building formation is suggested by the use of universal structure set. The possibilities of their use in the urban residential areas are studied. It is well reasoned that the decision on the choice of the commercial building structural system should be made following the objective evaluation of the particular situation, to provide for comprehensive development of the urban residential areas, presented as a project management system. The project deliverables will be the detailed design and technological documentation in the form of commercial buildings design projects.*

Key words: *comprehensive development; residence comfort; project management; structural organization; commercial buildings*

Introduction

Rational organization of trade and consumer services for the population is one of the most important and challenging tasks in the last three decades. One of the major goals in shaping service system for people is the urgency of comprehensive development of the urban residential areas in Ukraine. On the one hand, permanent buildings of trade and consumer services in the current urban residential areas, have a number of significant shortcomings, which reduce their efficiency due to rapid technological changes in production of goods and services [1]. The constructed buildings of service enterprises which lack flexibility of space planning decisions are getting obsolete in economic, technological, architectural and aesthetic aspects [2].

Buildings and structures designed without or little consideration of perspective social, functional, economic and town planning requirements, are getting outdated 4-5 times quicker as against their real depreciation [1]. On the other hand, the construction of trade and consumer services facilities lags essentially behind residential housing which results in prolonged absence of residence comfort during the period of area development. It is possible to increase the efficiency of capital investments in construction of the trade and

consumer services community buildings by virtue of reduction in consumption of materials, decrease of labour costs, speed-up of building commissioning.

At the present stage the research has encompassed the issues of structural organization of trade and community services buildings including trade and public catering outlets and local commercial centres of basic services to the local residential community members, limited to their influence on the problem solution.

Review of publications and problem statement

The current trends in architectural typology of public buildings including trade and consumer services buildings are examined in several publications [3, 4]. Structural features forming public buildings are of significant practical and research interest. This is proved by multiple works of such researchers as V. Abyzov, M. Akulenko, A. Gayduchenya, E. Gusseva, V. Yezhov, M. Kolyakov, V. Kutsevich, O. Sleptsov, G. Shemssedinov and others. It seems appropriate to supplement the study of structural organization features of trade and consumer services community buildings by application of the open architectural structural systems, light metal structures, and structural systems developed on their basis.

The objective of the article

The objective of the article is to ascertain specificity of structural organization of trade and consumer services community buildings, increase the efficiency of capital investments, which is reflected in the project management system in particular as regards the project final product, – the outcome of the research work, design and technological documentation developed for the client. To achieve the goal it is necessary to accomplish a number of tasks including: analysis of contemporary methods and techniques of constructing trade and consumer services community buildings; defining the efficiency of different structural systems; review of the advantages and limitations of the current systems; detecting the efficient application domains of different structural systems in the real built-up environment and in the new urban residential areas under development; assessment of the main advantages and recommendations on structural solutions application.

Presentation of the main research material

Despite current economic crisis in Ukraine the expediency of comprehensive development of the urban residential areas has not lost its relevance. In particular the most relevant under the circumstances is the quest for new formation possibilities for the trade and consumer services buildings with consideration of their structural organization specificities, technological advantages, efficient means of recovering additional expenditures and resources. A closer look at the peculiar functional hierarchy of project, programme and project portfolio management is required. Project is defined as a set of interrelated activities, performed by a specially appointed team within a given budget and during a certain period of time for providing unique deliverables (product, service) [5]. In this way, the project can be featured as a space planning solution of the trade and consumer services buildings based on the accepted structural concept.

Let's examine the main structural solutions of public buildings, which can be used for shaping the trade community buildings.

One of the perspective trends in building design under consideration is the use of cast-in-situ structures. Of paramount importance are such merits as minimal dependence on production base, relatively low initial investments, quick payback and the short time frame for the deployment of specialized construction companies. Relatively low requirements to workforce skills, as well as technological flexibility enable the construction of a building with any number of storeys and manifold design solutions providing for high comfort level.

Exactly these benefits taking precedence over panel housebuilding and brick construction with precast concrete floors, have promoted cast-in-situ house building in the most developed countries of the world [6].

One of the effective approaches to further development of the services sphere, taking into account urban territory saving and building density increase, is accommodating community facilities on the lower storeys of apartment buildings. The development of the cast-in-situ house building enhances the scope of lower floors design organization in apartment buildings maintaining differentiated approach to erecting residential and non-residential floors of different structural systems [7].

The so called precast and cast-in-situ table (block stylobate) with uniform frame is promising in terms of design and construction of built-in, and built-in and attached consumer services facilities. Such a system allows designing hall type facilities of social sphere.

Reviewing new architectural structural systems, "open" and "closed" systems in public buildings construction are worth mentioning. Open type system is designed for a gradual transition from closed structural systems developed only for specific design project or a range of design projects, to building design based on application of a single unified catalogue of industrial products and books of normals of architectural planning elements [8].

This will let to move away from the rigid practice of multi-copy use of limited number of typical design projects, which as a rule led to uniformity and monotony in the built-up environment. Open structure systems based on the use of interchangeable mass standard products, developed irrespective of the facility, ensure great variability of design solutions and possess planning flexibility during the upkeep of building. These systems make it possible to develop buildings of any configurations, create a variety of space-plastic compositions, arrange an open plan and transformation of the internal space. Along with the advancement of industrial frame- and panel-based construction on the basis of prefabricated frame (frame and girder systems), research and exploratory development of new girderless (flat) floor constructions which rest on columns without secondary beams and flooring joists, are in progress. Structural system of girderless ossature has significant benefits as compared to girder and other traditional systems. Utilization of such systems gives new opportunities as for variance of architectural planning and compositional solutions. The flat floor constructions with plain ceilings enable flexible planning implementation (construction of demountable or movable partitions not rigidly connected to structural elements of the ceiling). Installation of flat floor slabs

in the interior has also entirely building advantages: reduction of materials consumption for preparation of formwork due to the absence of girders (cast-in-situ mode of production), reduction of the ceiling area for subsequent processing and ease of finishing, applicability of low-slump concrete, simplification of installations attachment on the ceiling. The availability of flat ceilings improve indoors sanitary and hygiene conditions because there are no more poorly ventilated spaces between girders and shadowy places, dust accumulation is lessened, etc. Alongside with the aforementioned benefits girderless systems have certain disadvantages which hinder their wide introduction in construction production. The flat floor slabs are more limited in size than those of traditional girder systems; not always flat floor manufacturing is cheaper and easier. But the drawbacks inherent in girderless systems are mostly related to structural part, and can be removed upon its improvement.

The Kiev research institute of theory and history of architecture and town planning (NIITIAG) has developed architectural structural system "POLISS" based on girderless frame which includes columns, column strip (base) and longitudinal floor slabs adjacent to each other at angles of 45° and 90°. Geometric net of this frame allows to achieve different cell parameters, and accordingly the column grid, for example, 6,6 x 6,6; 9 x 9; 13 x 13m (research supervisor – A. Abyzov). This solution envisions the use of two main standard size floor slabs to bridge over various spans. The POLISS outer wall system may be made of prefabricated panel and block industrial elements, as well as of local masonry (brick, cinderblocks, others), and are performed as curtain wall, self-supporting and load-bearing structures respectively. The simplicity of constructive elements manufacturing technology (no prestressing, voids, etc.) makes it possible to arrange their production at the concrete products factories, and in the field. The suggested system can be implemented in normal and complicated geological conditions [9].

The architectural bureau "LITSENZiARCH" developed a versatile prefab open frame prefab structural system "KASSKAD" intended for the design and construction of civil buildings, which provides for a variety of space-planning building solutions of multiple functionality based on the limited range of structural elements (chief of development – O. Sleptsov). The optimal small cells interior space in all types of public and dwelling buildings ensures the use of minimal span of 7,2 m. Should the spans be increased from 3,6m to 18,0m, the use of the open prefab frame system "KASSKAD" elements enables interiors with complex configurations of rectangular, triangular and curvilinear outlines. Space construct can be developed in three dimensions, including elements of internal galleries,

stairs, area lights. While designing three-dimensional spatial interiors of multifunctional public buildings, such as educational establishments, commercial, sports and recreation, and leisure centres, one can achieve the greatest effect by combining small cell spaces with hall type interiors [10, 11].

The Kiev regional research design institute of civil construction (KievZNIYEP) in partnership with the Kiev "Remtorgoborudovaniye" manufacturing group designed an architectural structural system named "Aktiv". The system is based on the flexible planning network of columns with side proportion of 2:1,73 (6,6 x 5,7m). The "Aktiv" system development gives the opportunity to meet all kinds of urban planning, typological, aesthetic and other architectural requirements and contributes to the design of variable space plastic interior compositions. The "Aktiv" system implies the use of light metal structures, efficient materials and includes: formed section columns, trussed rafters and secondary trusses made of angles or pipes, light siding sheets, roof slabs and complex roof coating. This system structures are designed as demountable and are meant for building one-storey pavilions. The new system is remarkable for its universal, transformational and mobile properties which might be a crucial criterion. It can provide for construction of childcare facilities, trade and consumer services centres, warehouses, depots, coach terminals, market and exhibition pavilions, etc. One of the major advantages of this system is that it is demountable. It gives big opportunities in terms of the whole structure mobility, transformation of separate interiors while in operation, quick alteration of production technology, change of the cross-section capacity and specialization of enterprises. Hence, reconstruction and enlargement of buildings, their adaptation to the current development conditions, transfer to new locations are possible [1].

To a large extent these requirements are met thanks to the light metal structures which are widely used in construction of consumer services enterprises in other countries. The light metal structures used in design and construction of consumer services enterprises will allow, along with rational planning which fully meets the advanced requirements of technological functioning conditions, to receive a space structure, that ensures adaptation of these buildings to changing demands and terms with minimal time and resources consumption. Besides, it will enable stepwise formation of the consumer services network in the residential area in accordance with the phased commissioning of apartment buildings, and contribute to comprehensive development of the area due to the newly built permanent or temporary service facilities.

The team including author of the article, led by A. Gayduchenya, developed a new design technique based

on universal sets of light metal structures utilizing the AKTIV system. At the core of the design is the task to obtain a variety of space planning solutions of buildings with a minimal number of standard sizes of supporting and walling structures, and by maximal industrialization of structures manufacturing and assembling. Architectural design solution of a children's café for 150 seats with an area of one thousand m³ was chosen as a standard test model. There were eight different space planning solutions developed for trade buildings with various outlines, using a set of supporting and wall structures of the café building.

Flexible planning arrangement of the buildings is foreseen including possibility of demountable structures transformation. A set of enterprises embraced by architectural structural models is not static – the buildings are uniform and provide for variability of functioning layouts. It is assumed that the client receives a set of structures and a catalogue of possible space planning and functioning solutions.

Under the impact of changing social and town planning factors, after a certain operational period, the building can be reconstructed, or demounted and transferred to another site. In the new conditions the building can be assembled again or another building from the catalogue can be erected with the help of the available set of structural elements [12].

At the same time metal structures as compared to reinforced concrete structures are characterized by reuse of material. After physical and moral deterioration steel structures get remelted in a smelter, and then new structures are made, i.e. they can be endlessly reproduced with a little loss. The dismantling of outdated reinforced concrete structures is very expensive, and in addition, they are non-recyclable as a rule [13].

The duration of construction from light metal structures is an essential economy factor. Z. Angelov formulated the mathematical model of economic effect of accelerating the commissioning of facilities:

$$E = ENF(T_1 - T_2) = ENFT,$$

where E – economic effect; F – the cost of fixed capital assets, put into operation; EN – normative investment effectiveness ratio; T₁ – T₂ – the difference in work duration for long-term and short-term versions of construction.

Therefore it is possible to gain a one-time effect of extra profit gained from an early commissioned operating facility. Reduction of the construction time of individual trade and consumer services enterprises enables an additional economic effect due to their early commissioning. For example, a 15-20% reduction of the planned timeframe for a commercial facility construction not only makes up for the difference in the

budget cost of construction with the use of aluminium wall structures but also gives a chance to gain extra profit because of the early trade turnover exercised by the enterprise [14].

Conclusions

The review of the current research, design and construction data base as regards the construction of trade and consumer services enterprises, revealed big opportunities for residential areas comprehensive development. Further industrialization of the construction sector along with the improvement of architectural expressiveness of the developed area can be achieved by introduction of the advanced architectural structural systems and expansion of the scope of industrial building techniques. The intention to improve the urban development is reflected in many research papers and practical application of the open prefabricated structural systems, such as "POLISS", "KASSKAD", "AKTIV" and others.

In some cases it is efficient to employ cast-in-place housing construction, accommodate the built-in and attached consumer services facilities on the lower storeys of apartment buildings, use block-stylobate with uniform frame.

Prerequisites of imparting the new plastic properties to the architecture of trade and consumer services buildings made of light metal structures are as follows: 1. decrease of labour intensity and reduction of the construction timeframe – accentuated prefabricability, revealed constructability, structural properties; 2. construction cost reduction – simplicity and laconism, compactness of solutions, versatility and standardization of volumes and details, typification of techniques; 3. decrease in weight of buildings – underscored lightness of structure, refinement of element sections, openwork structures, and modularity.

Utilization of light metal structures contributes to: shortening of construction time; cost reduction of the structure due to industrialized manufacturing; decrease of labour intensity during building mounting; saving of construction materials during reconstruction; possibility of phased construction.

Further study of the problem of development and improvement of the research and methodological approaches to holistic analysis and solutions for comprehensive development of the urban residential areas is a perspective trend.

The project management system allows maintaining individual approach to development solutions, and selection of structural organization of buildings. Optimization of solution choice will help to minimize potential risks, strengthen business positioning, improve decision making, and enhance the living comfort for residents in the urban areas.

References

1. Gayduchenya, A.A. (1983). *Dynamic architecture (The main trends of development, principles, methods)*. Kyiv, Ukraine: Budivel'nyk, 96.
2. Abyzov, V.A. & Kutsevich, V.V. (1990). *Architecture of public buildings with flexible planning*. Kyiv, Ukraine: Budivel'nyk, 112.
3. Kutsevich, V.V. (2014). *Architectural typology of public buildings and structures. Current trends of development. Contemporary issues of architecture and town planning*, 35, 376-384.
4. Kutsevich, V.V. (2009). *Commercial enterprises. Architectural typological peculiarities and regulatory support of their design and construction. Construction in Ukraine*, 9-10, 9-15.
5. Verba, V.A. (2009). *Preconditions for the successful implementation of development projects. News of the Kryvyi Rig economic institute*, 3(19), 34-39.
6. Hlyna, Yu. V. & Abramson, L.A. (1992). *Cast-in-situ housing construction: condition, trends and prospects. Architecture and construction in Russia*, 7, 26-30.
7. Kutsevich, V.V. (1991). *Facilities of public services in lower storeys of residential houses. Housing construction*, 1, 13-15.
8. Yezhov, V.I., Yezhov, S.V. & Yezhov, D.V. (2006). *Architecture of public buildings and complexes*. Kyiv, Ukraine: VISTKA, 340.
9. Abyzov, V.A. (2009). *The theory of development of architectural building systems*. Kyiv, Ukraine: KNUKIM, 240.
10. Sleptsov, O.S. (2010). *Architecture of civil buildings: industrialization*. Kyiv, Ukraine: A+C, 248.
11. Yezhov, V.I., Sleptsov, O.S. & Gusseva, Ye.V. (1998). *Architectural structural systems of civil buildings*. Kyiv, Ukraine: LITSENZiARCH, ArtEk, 333.
12. Chernyavsyi, V.G. & Shemsedinov, G.I. (1987). *Formation of demountable buildings with the use of universal structural sets. Construction and Architecture. Apartment and public buildings*. Kyiv, Ukraine: Budivel'nyk, 22, 47-54.
13. Mel'nikov, N.P. (1983). *Metal structures*. Moscow, Russia: Stroyizdat, 55.
14. Yezhov, V.I. (1981). *Architectural structural systems of public buildings*. Kyiv, Ukraine: Budivel'nyk, 120.

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КОНСТРУКТИВНІ ОСОБЛИВОСТІ ФОРМУВАННЯ ТОРГОВЕЛЬНИХ БУДІВЕЛЬ СОЦІАЛЬНОЇ СФЕРИ У СИСТЕМІ КОМПЛЕКСНОЇ ЗАБУДОВИ

Анотація. Необхідність комплексної забудови житлових районів міст України, яка представлена як система управління проектами, передбачає реалізацію стратегічної мети – підвищення рівня комфортності проживання населення за рахунок застосування різних конструктивних рішень торговельних будівель соціальної сфери. Проведено аналіз конструктивної організації громадських будівель, на основі якої можуть формуватися торгові будівлі соціальної мережі обслуговування. Виявлено переваги різних архітектурно-конструктивних систем, розроблених в науково-дослідних інститутах та архітектурних бюро. Використовуючи теоретичні і практичні розробки, виявлено переваги різних конструктивних систем при формуванні дрібночарункових та зальних приміщень торгових будівель. Відзначені переваги використання легких металевих конструкцій та архітектурно-конструктивних систем, розроблених на їх основі. Пропонується нова методика формування будівель соціальної сфери на основі універсального набору конструкцій. Розглянуто можливості їх застосування у структурі житлових районів міст. Аргументовано, що ухвалення рішення про використання певної конструктивної системи торговельних будівель повинно здійснюватися на основі об'єктивної оцінки конкретної ситуації для забезпечення комплексної забудови житлових районів міст, представленої як система управління проектами. Продуктами проекту при цьому можуть бути проектно-конструкторська, робоча і технологічна документація у вигляді проектів торгових будівель.

Ключові слова: комплексність забудови; комфортність проживання; управління проектами; конструктивна організація; торговельні будівлі

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КОНСТРУКТИВНЫЕ ОСОБЕННОСТИ ФОРМИРОВАНИЯ ТОРГОВЫХ ЗДАНИЙ СОЦИАЛЬНОЙ СЕТИ В СИСТЕМЕ КОМПЛЕКСНОЙ ЗАСТРОЙКИ

***Аннотация.** Необходимость комплексной застройки жилых районов городов Украины, которая представлена как система управления проектами, предполагает реализацию стратегической цели – повышение уровня комфортности проживания населения за счет применения различных конструктивных решений торговых зданий социальной сферы. Проведен анализ конструктивной организации общественных зданий, на основе которой могут формироваться торговые здания социальной сети обслуживания. Выявлены преимущества различных архитектурно-конструктивных систем, разработанных в научно-исследовательских институтах и архитектурных бюро. На основе теоретических и практических разработок, выявлены преимущества различных конструктивных систем при формировании мелкоячеистых и зальных помещений торговых зданий. Отмечены преимущества использования легких металлических конструкций и архитектурно-конструктивных систем, разработанных на их основе. Предлагается новая методика формирования зданий социальной сети на основе универсального набора конструкций. Рассмотрены возможности их применения в структуре жилых районов городов. Аргументировано, что принятие решения об использовании определенной конструктивной системы торговых зданий должно осуществляться на основе объективной оценки конкретной ситуации для обеспечения комплексной застройки жилых районов городов, представленной как система управления проектами. Продуктами проекта при этом могут выступать проектно-конструкторская, рабочая и технологическая документация в виде проектов торговых зданий.*

***Ключевые слова:** комплексность застройки; комфортность проживания; управление проектами; конструктивная организация; торговые здания*

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