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MULTIVARIATE ARCHITECTURE-&-CONSTRUCTIVE SYSTEM ON THE BASIS OF BEAMLESS FRAMEWORK

Abstract

The article presents methodological principles for forming the multivariate architecture-&-construction system on the basis of a new beamless framework. The idea of system's creation and application was briefly characterised. Some advantages of its implementation to construction practice are presented.

Keywords: multivariate architecture and constructive system, beamless framework, urban environment, construction

1. Introduction

The solution of Sustainable Urban Development and Housing problems is impossible without new approaches and methods of designing, development, management, and co-ordination of architectural, engineering, technological and industrial decisions. Architecture-&-construction systems (ACSs) play here the important role and are directed at forming a friendly environment. This term is used to refer to a system of coordinated architectural, construction, and technological decisions, which proceed from a universal methodology. Similar systems are known in housing practice in Eastern Europe, but they do not correspond always to modern social and economic requirements [1]. All said above explains the need to improve the existing systems and design new ones, which will allow a variety of spatial solutions and architectural structures implementing comprehensive approaches and systematic decisions [2, 3].

Prefabricated large panel systems and its large-scale structural elements lead to numerous repeated of architectural and environmental decisions and don't allow to take into consideration various social, typological, urban and other conditions [4].

Application of beamless framework provides the possibilities of flexible lay out and enlargement of spatial and environmental decisions and also reducing material spenders. At the same time improvement opportunities (perfection's reserves) of this kind of framework are not settled.

2. General IDEA of the System

Along with a longstanding scientific and practical work of improvement and prospects for the

development of existing ACSs in Ukraine, the author of this article invented and introduced in design and construction practice new universal architectural-construction system "POLIS" on the basis of beamless framework. A patent of Ukraine №19 was received [5].

Beamless framework includes columns (set along the perimeter cells formed by the intersection of the stakeout of the axes of columns), flat overcolumn slabs (plates) with square shape, and span slabs with trapezium-shaped forms. Overcolumn slabs have holes for passes columns with a rigid joint of their connection.

Framework's cells are located at 45° and/or 90° one to each other and have the shape of a rectangle, including square and/or an isosceles right triangle (Fig. 1). Transition from one span to another is based on the using of the diagonal of the previous cells like the side of following cells.

The basic column grid for primary square cell is 6 x 6 m. Column grid for secondary cell is 8.5 x 8.5 m. Next cell is 12 x 12 m, etc.

Adopted grid provides the possibility of creating on the base of unified constructive module rational parameters of rooms and a wide range of functional and structural decisions of the civilian buildings (Fig. 2). It assumes the use of two main sizes of overlap's plates made in unified shuttering forms. For spans of 8.5 m or more applying additional load-bearing structural elements are provided that logically fit into the accepted constructive scheme of the framework such as strutted frame or other spatial load-bearing structures. Their main supporting element is connected with the central span plates by the "ties" that transmit the external forces on supporting framework's columns.

In order to obtain a wide variety of spatial and architectural decisions of buildings extra slabs (plates) of overlap derived from forms of two major plates, using their unified shuttering forms or additional monolithic sections could be also applied. Application of extra plates with width of 1.5 m allows to offload perimeter columns, gives the opportunity to obtain diverse plastic architectural structures, as well as constructive span of size 3 m. It is also providing the possibility of variation of parameters of the column grid.

Installation of the frame is done by the following way: overcolumn slabs are set on the columns due temporary telescopic balks or supporting adjusting pins, which inserted into the holes in the columns.

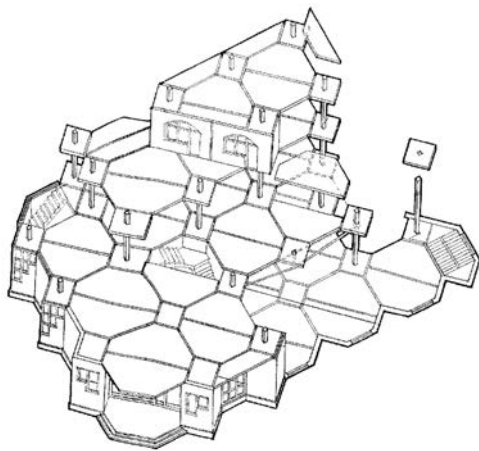


Fig. 1. Principle view of architecture-construction system "POLIS" on the basis of beamless framework

Overcolumn slabs have rigid connection device with columns. Between overcolumn slabs are placed span slabs with trapezium-shaped forms that based on appropriate installation elements (Fig. 3). For large bays (8.5 m and more) in the centres of cells are used as span plates the same overcolumn plates. After completing the assembly joints gaps between slabs are embedded (performed butt joint grouting) [6]. As a result hard disk beamless overlap has created (Fig. 4).

After conducting of research and design work the testing was carried out, installation and perfection of the system (Fig. 5). Multivariates testing of the system have shown positive results and operational reliability of the system (Fig. 6).



Fig. 2. Design of multifunctional complex on the basis of a System

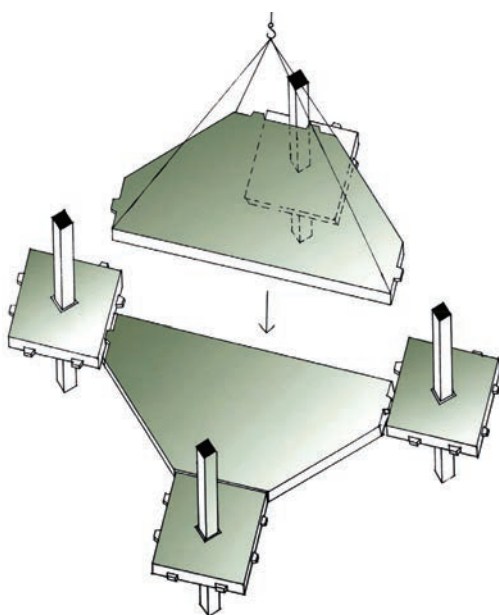


Fig. 3. The scheme of framework's assembly

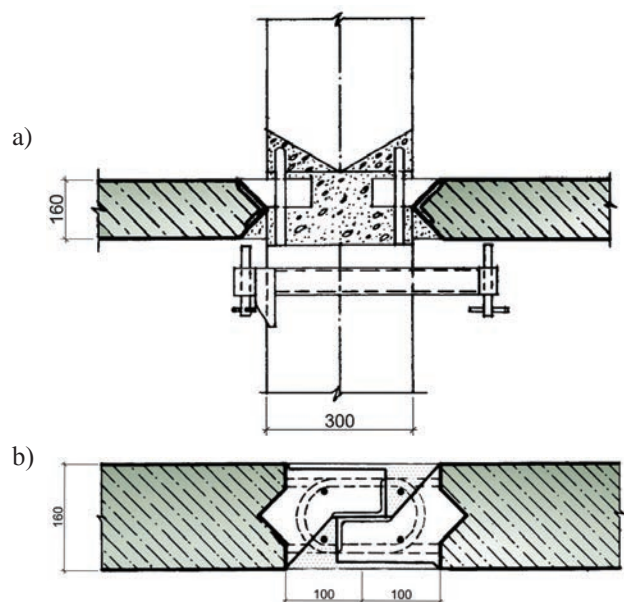


Fig. 4. Structural joints: a) column with overcolumn slab, b) span's slabs

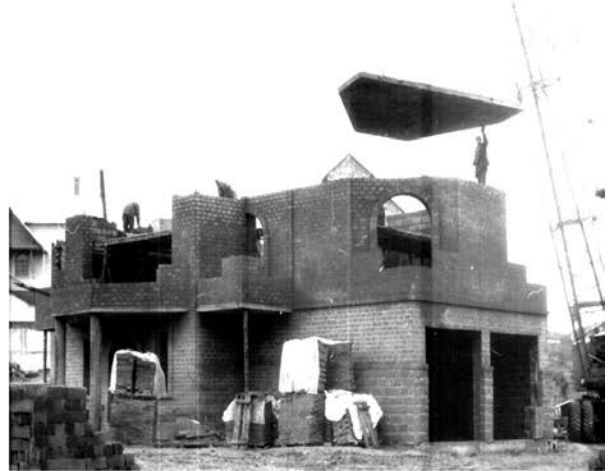


Fig. 5. Installation of the system

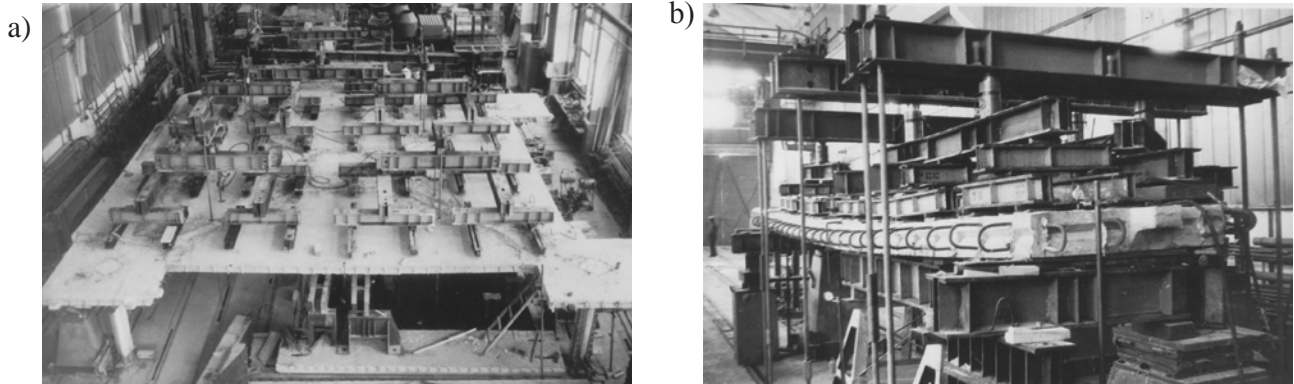


Fig. 6. Testing of the system: a) main system's fragment, b) span's slab

3. Application of the System

Architecture-construction system "POLIS" is intended for the construction of various types of residential, public and industrial buildings of different height. This system is universal, not only due to its flexibility of architecture and constructive conceptions, but also due to the possibilities of its implementation in different construction's

technologies. For example, the framework can be accomplished in both cast (monolithic) and prefabricated concrete. External walls can be also performed in concrete or in block materials and, therefore, be determined as self-supporting or load-bearing structures. In the latter case mixed (incomplete) framework without the perimeter columns has resulted (Fig. 7).

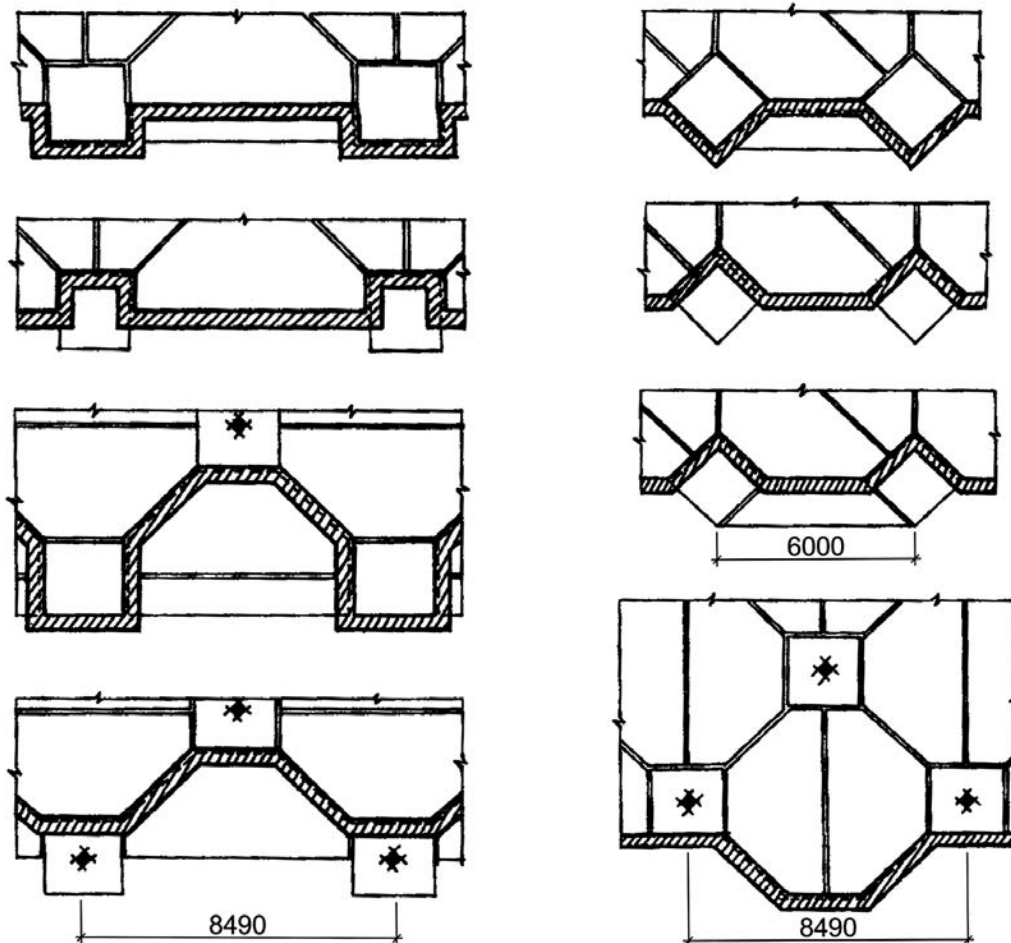


Fig. 7. Conception variants of system's external walls

Due to the reduced number of prefabricated reinforced concrete elements substantial economic effect has occurred in comparison with the existing structures.

At the same time this system provides the opportunity to obtain high aesthetic qualities of architecture environment without using additional monolithic sections (Fig. 8).

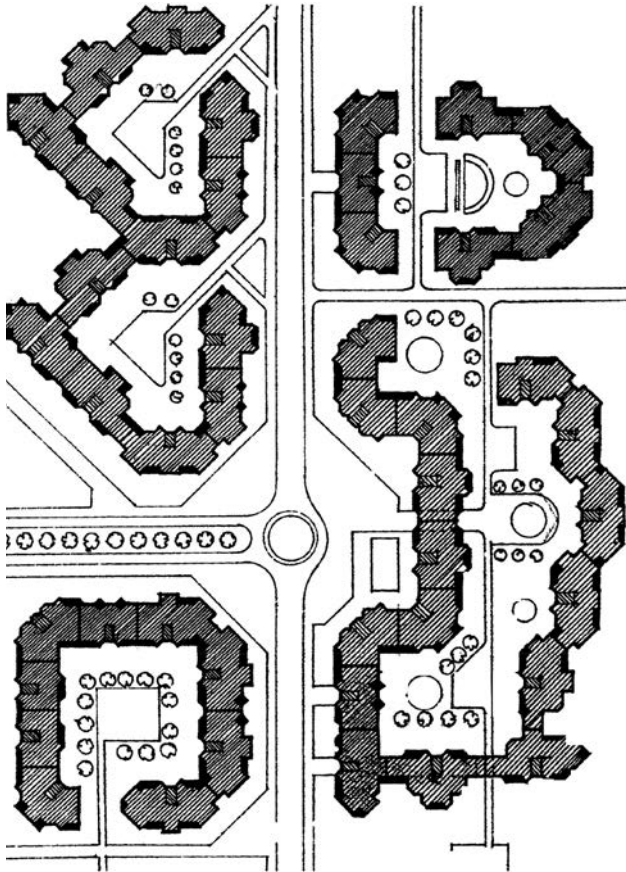


Fig. 8. Urban diversity on the basis of the system

The simplicity of the manufacturing technology of structures and its small capital intensity, effective solutions for external walls enable its implementation by both big and small investors and construction firms, as well as reducing the investment cycle, labour costs and capital investments [1, 5].

4. Conclusions

The main advantage of this system is universality: covering of spans and spaces of different sizes and configurations on the base of limited range of type-dimensions; providing the possibilities of construction on the base of a unit technology of various laying out, architectural and urban decisions of civil and industrial buildings; rising of architectural expressiveness of environment and constructive density of residential area on account

of orthogonal and polygonal structural decisions; carrying out of complex and efficient construction. Particular significance has the qualitative aspect and possibilities of improvement of architectural and aesthetic qualities of the environment without additional expenditures.

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