

ARCHITECTURE-&BUILDING SYSTEMS IN CIVIL CONSTRUCTION

SYSTEMY ARCHITEKTONICZNE I BUDOWLANE W BUDOWNICTWIE CYWILNYM

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Abstract

The article deals with the role of Architecture-&-Building systems in Residential and Public Construction. The concept and definition of the Architecture-&-Building systems are determined and reviewed. The structural model of Architecture-&-Building systems that have signs of integrity, the hierarchy of structure and openness is proposed. They include three main subsystems, which are in organic unity and interaction: functional-spatial (architectural and planning); constructive (tectonic); technological (production-building).

Keywords: Civil Construction, Architecture-&-Building Systems, structural model

Streszczenie

Artykuł dotyczy roli systemów architektonicznych i budowlanych w budownictwie mieszkaniowym i publicznym. Koncepcja i definicja systemów architektonicznych i budowlanych są określone i przejrzone. Zaproponowano model strukturalny systemów architektonicznych i budowlanych o oznakach integralności, hierarchii struktury i otwartości. Te systemy obejmują trzy główne podsystemy, które są w organicznej jedności i interakcji: funkcjonalno-przestrzenne (architektoniczne i planistyczne), konstruktywny (tektoniczny), technologiczny (produkcja-budynek).

Słowa kluczowe: budownictwo cywilne, systemy architektoniczne i budowlane, model strukturalny

1. INTRODUCTION

Housing is one of the most important social and economic problems. It has become a priority task, as well as the creation of modern environment, which would enable a Sustainable Development. It is obvious now, that the solution of Housing and Urban Development problems is impossible without new approaches and methods of designing, development, management, and co-ordination of architectural, engineering, technological and industrial decisions. Architecture-&-Building Systems (ABSs) play here the main role. This term is used to refer to a system of coordinated architectural, constructive, and technological decisions, which proceed from a universal methodology. The ABSs are directed at forming a friendly environment and simultaneously are the material and technical means of realizing such environment of the system of material entities [1].

At the same time, the need to create a fully-fledged living environment and solve the problems of the

complexity and aesthetic qualities of residential development depends largely on the use of advanced architectural and urban development solutions and the implementation of efficient building structures, materials, products, and technologies, and the improvement and transformation of the material and technical base of construction [2, 3, 4]. It should be noted the availability of modern methods for the integrated assessment of such solutions in the context of sustainable design in the works of Professor L. Kamionka [4, 5]. At the same time the key issue is determining the development strategy and prospects for improving the architectural and construction systems of civilian buildings.

Such systems are known in housing practice. It's basically like prefabricated large-panel systems, prefabricated framework systems, modular cell systems, block systems, monolithic systems, and their combinations, but they do not always meet modern social and economic requirements and

constantly improving. At present the building market is changing and growing, featuring new diverse construction decisions. [1-9]. For a holistic view and a comprehensive solution for this problem, it is necessary to consider and define the concept, definition and structural model of the ABS, what is the purpose of this article.

2. THE CONCEPT AND DEFINITION OF THE ARCHITECTURE-&BUILDING SYSTEM

The term “Architecture-&-Building system” (ABS) is not new in design and construction practice. It is widely used in various studies and publications, normative and methodological documents, mostly in Eastern Europe. However, there is no clear definition of this term. Along with this, terms such as industrial systems, building design and construction systems, prefabricated systems, framework systems and others are used [1, 3, 6, 7, 8, 10]. At the same time in the most part of various publications buildings and structures and their constructive components and elements as systems are considered. Before giving the terminological definition of ABS, one should consider the existing terminology of related concepts.

The most common and stable term is “constructive system” (CS). However, this term is interpreted differently in various studies. The following definitions of the CS are known:

- “a set of solutions supporting and protecting structures that provide spatial rigidity and stability of buildings” [10];
- “spatial bearing skeleton which consists of vertical and horizontal elements that provide a static work of building, its stability” [11].

As the functional and architectural aspects are usually crucial for the CS, the most reliable interpretation of it as a subsystem of the architectural system is given in the studies by Professor B.G. Barkin: “The constructive subsystem is realized by material and technical means and provides stability, strength, durability and fire safety” [12]. In other words, a constructive system should be considered as part of more complex systems – architectur & constructive (architectural & structural) and architecture & building (architectural & construction), in which no constructive element or part can be constructed and evaluated in isolation. Ignoring such design leads to serious mistakes, failures, violations of the relationship between structure and form, worsening conditions of buildings and so on. Examples of this may be the first prefabricated large-panel and frame-

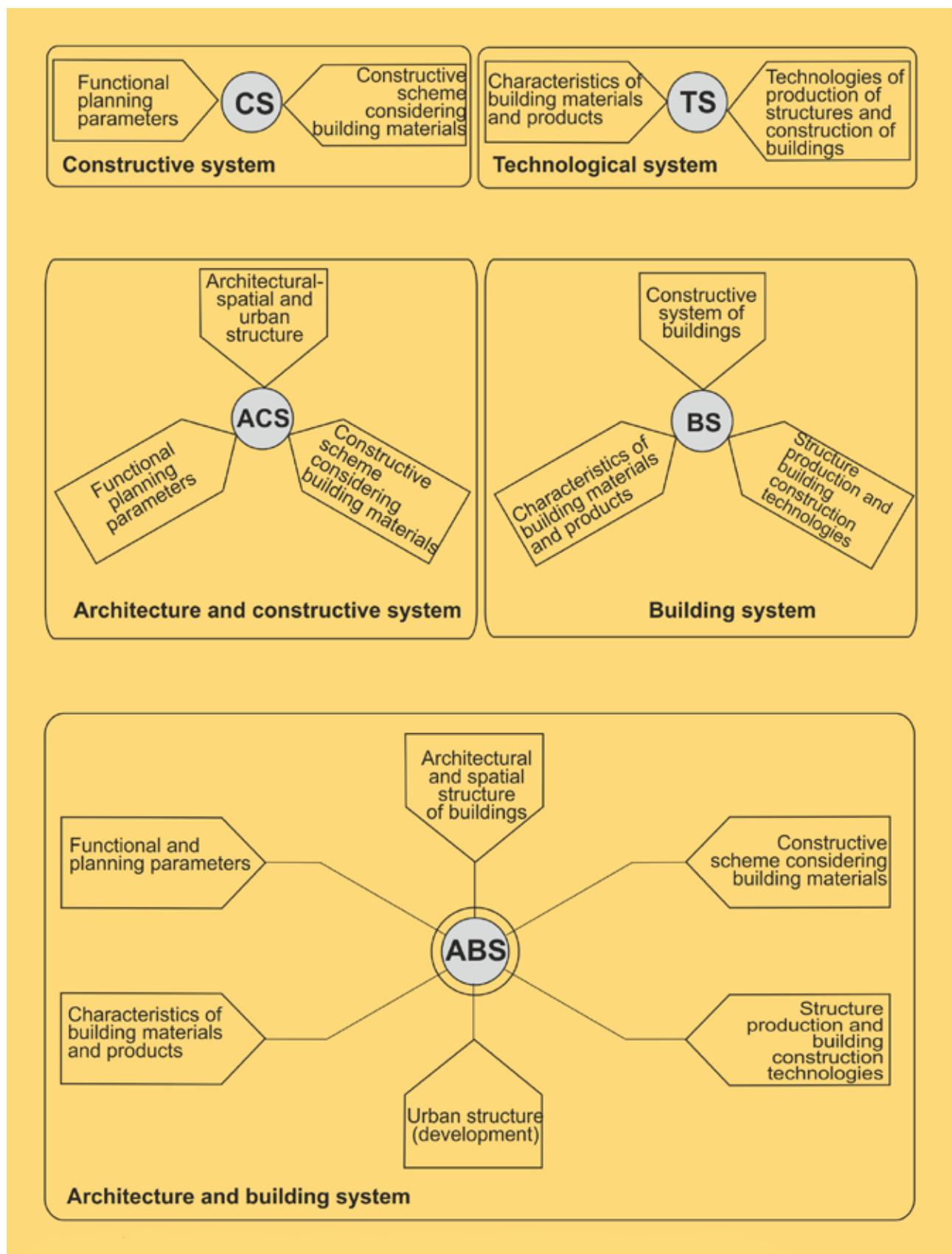
panel buildings in Eastern Europe, designed only on terms of statics, technology and economy of materials. Correction of such errors in the conditions of factory homebuilding requires a restructuring of production and leads to economic and moral losses.

In this regard, it is logical and justified, in our opinion, the emergence and spread of the term architecture and constructive system (ACS), which subsequently became applied in further researches and design [10]. However, despite this, the definition of this term is absent. Along with this became the extension of a term as a building system (BS), which is a combination of a certain construction method with a certain constructive system in the application of specific technology. In turn, the construction method is a way of erection of buildings, for example, a large-panel or monolithic method (Fig. 1).

It is worth to mention here the definition of the term as a “combined building (construction) system” – “the combination of two or more building systems or their individual elements, for example, a building constructed by one construction method, in which vertically and/or horizontally combines different constructive systems, or vice versa, the application of one constructive system uses a combination of different methods of erection. [13]. In addition, other definitions and terms that belong to the subject of research and reflect its essence (mainly a technical point of view) are known – structural and technological systems, design and production systems, systems of industrial residential houses, etc. [1-9].

The given terminology does not exhaust all the definitions adopted by different experts, which often complement each other, but generally have a local character, since in most of them lack such an important and comprehensive concept as the architecture, which underlies both constructive and building systems. This largely reflects not only the functional aspect from the point of view of terminology, but also its essential aspect.

Since the formation of each building is impossible without a complex of architectural requirements and urban conditions, it is most expedient to operate such terms as architecture & constructive systems and architectural & building systems. At the same time, the latter most accurately and fully reflects the phenomenon of the integration of architecture and industrial homebuilding and embodies in its name the whole complex of not only urban, architectural, constructional, but also construction and technology issues (Fig. 1).

*Fig. 1. Main characteristics of systems of residential and public construction*

Rys. 1. Główne cechy systemów w budownictwie mieszkaniowym i publicznym

The author understands the architecture & building system as a set of interrelated architectural, constructive and technological solutions, which are based on uniform methodological principles of housing environment formation and provide realization of a complex of socio-demographic, urban planning, functional and lay out, technical, technological, environmental, economic, aesthetic and other requirements [1].

It should be noted that in fact the concept of ABS is two aspects of one phenomenon. The first is material and technical aspect, which is included in the system of material formations and technical means of realization of the living environment – from building to the apartment, and the second aspect is organizational and informational, which is examined in the system of public relations and management of urban planning as a certain program of appropriate targeted actions.

3. ARCHITECTURE & BUILDING SYSTEM MODEL

STRUCTURE AND ITS SUBSYSTEMS

In accordance with the terminology we adopt, architecture & building systems of civil engineering, intended to form a residential environment, should be presented in three main aspects: functional-spatial, constructive, and construction-technological. It can clearly define the range of phenomena associated with the organization and design of the material and spatial environment, which has an important methodological significance.

Author of this article believes that the ABS model (Fig. 2) should be considered as a complex system, which includes three subsystems: functional-spatial (architectural-lay out), constructive (tectonic), technological (production-building).

Each of these subsystems has a hierarchical range of its own interrelated structural elements, the further classification of which has an open nature that takes into account the multidimensional information and the degree of its interaction with other elements and their groups in solving specific architectural and construction tasks. Construction of the model structure of architecture & building systems and its operation will provide an opportunity to determine the nature of the system's behavior, predict its future state, trends and development prospects.

Functional-spatial subsystem (FSS) reflects the functional purpose of architecture & building systems, the main urban-planning characteristics, typological and architecture-spatial properties and

includes the following main blocks: "urban structure" (development) and "buildings".

Block "urban structure" describes the new territories and the territories of the existing buildings, which in turn, further divided into zoning on functional grounds, belonging to the protected areas, etc.

Block "building" is divided into sub-blocks "function" and "architecture and lay out structure". In the sub-block "function" distinguished by features of functional typology of residential buildings, public, industrial, multi-functional buildings (integrated complexes). Then these objects acquire a more detailed typological classification (Fig. 2). Thus, the typology of residential buildings covers apartment buildings and individual dwellings, which in turn are divided into: multi-apartment buildings – sectional, corridor, gallery and others; individual – separate, locked, duplex, etc. The typology of public buildings includes educational, commercial, cultural, sports, recreational, administrative and other types of public buildings. In the future, they have further and smaller classifications. Similarly, various industrial buildings and multifunctional complexes can be dissected according to functionally typological features.

The sub-block "architectural and lay out structure" includes fine-cell, big-celle, mixed-cell structures, which in turn can be divided into their varieties (Fig. 2).

Functional-spatial subsystem has its implementation in a constructive subsystem.

Constructive subsystem (CS) is a collection of interconnected vertical and horizontal structural elements, united in a single system according to the laws of building mechanics. At the same time, it has two main blocks, covering the decision of bearing and non-bearing structures. The latter block, in turn, contains a solution of the elements of the wall fences and the division of the interior space of the building (fencing and dismembering/separating structures). Thus, the constructive subsystem includes bearing, fencing and dismembering/separating structures. They, in turn, are divided into:

- bearing – on a planar (wall), frame (skeleton), volumetric (shell);
- fencing – on self-supporting, mounted;
- dismembering – on stationary, non-stationary, etc.

Fencing structures can also be used as bearing walls, but in this case they should be classified as bearing structures of the buildings. Further, the following division of these elements is possible according to the types of used building materials, methods of fastening and work of structures, etc.

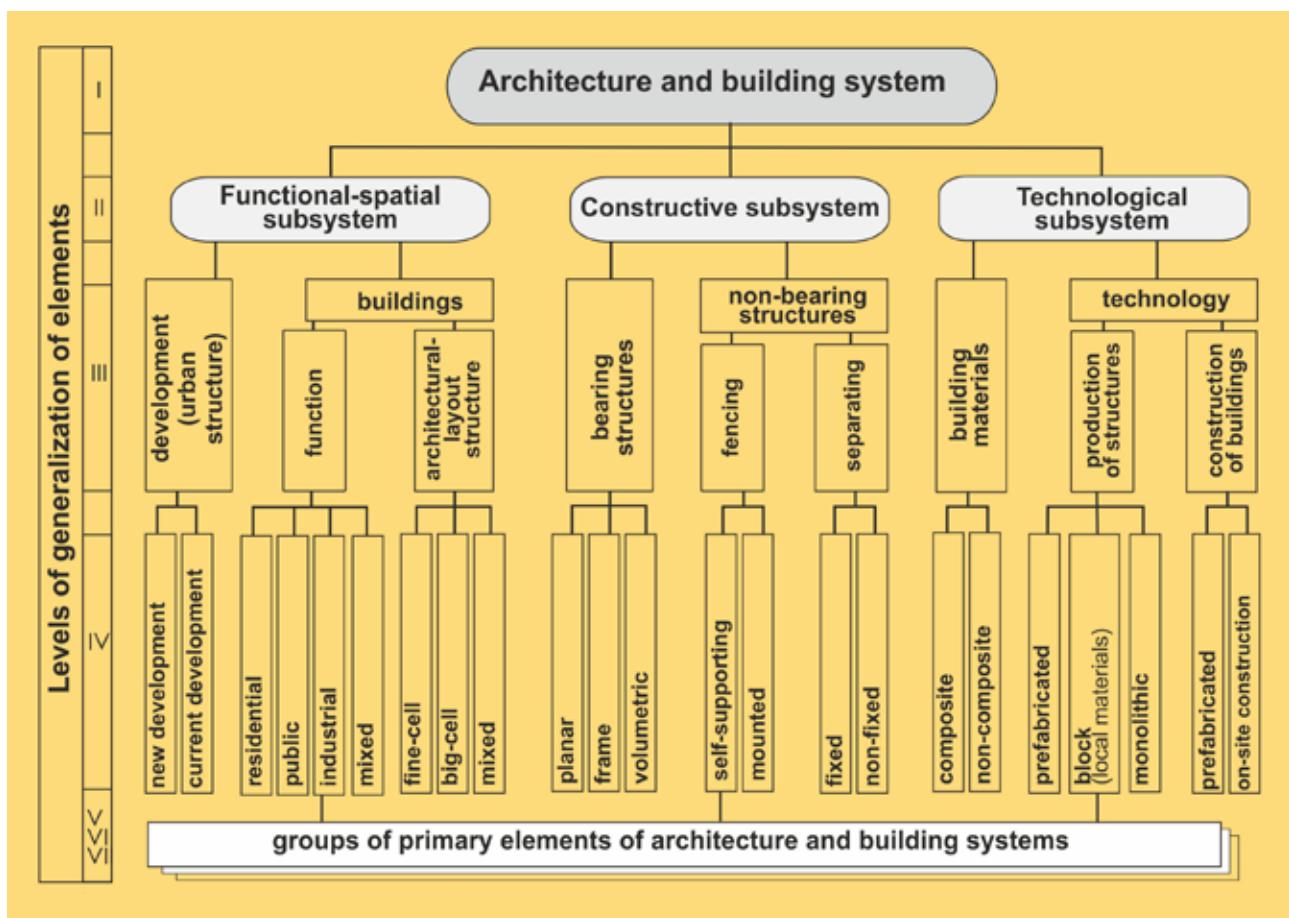


Fig. 2. The structure of Architecture-&-Building System model

Rys. 2. Struktura modelu systemów architektonicznych i budowlanych

Constructive subsystems that are the elements of the artificial environment system can not be considered separately. Their formation is determined by the typology of buildings, urban planning conditions, architectural design, i.e. the elements of the functional-spatial subsystem. Together, the functional-spatial and constructive subsystems form an architecture and constructive system (ACS), which is a subsystem of the architecture and building system of a higher hierarchical level. However, ACS as well as the CS does not include the specifics of varieties of building materials, technologies for the production of structural elements and construction methods, on the basis of which houses are erected. Each constructive system can be implemented in brick, prefabricated or monolithic reinforced concrete, etc. (Fig. 2).

Technological subsystem (TC) reflects the concrete production conditions for the implementation of architectural and design systems and includes the following blocks: "building materials", "technology". The latter in turn is divided into the technology of

manufacturing building products and technology of building methods (construction).

The block "building materials" includes non-composite (homogeneous) and composite (non-uniform) materials. In the sub-block "technology" of the production is allocated TO the production of structures and construction of buildings. The sub-block "production of structures" (technology as methods of construction) is divided into prefabricated, monolithic, block (from local materials), mixed (combined) methods of construction. These sub-blocks have such divisions. Factory technologies (production of structures) are divided into stand, cassette, aggregate-current, vibro-rolling, conveyor, conveyor-cassette, etc. "Construction of buildings" (building technology) has its own specific varieties. The prefabricated method includes large-panel, frame, modular cell construction, as well as various combined methods of prefabricated construction, as for example, frame-large-panel, modular cell-panel, and others. Monolithic building includes construction

with the use of removable formworks of multiple use and fixed formworks. Block method includes large block and small-brick construction.

These kinds of basic construction methods have in turn smaller division. The mixed (combined) method has a large variety of construction methods, which include various combinations of the above methods. Varieties of building materials and technologies in turn are divided into the classifications of lower levels of elements' generalization (Fig. 2).

The combination of building methods and materials with a certain constructive system is a constructive-technological or building system (BS). That is, the constructive and technological subsystems are the building system. And together with the functional-spatial subsystem it forms an architecture and building system [1].

4. CONCLUSIONS

The concept of architecture and construction system, which is distributed in professional language and literature, is defined in this article. The proposed structure of the ABS model consists of three hierarchically subordinate subsystems and provides classification at the lower levels of elements' generalization – up to the primary elements of architecture & building systems. It has an open character that allows it to be operated. This gives also possibility to consider the prospects of further development and improvement of systems and a wide range of architectural and engineering tasks. Examined terminology and ABS model and its structure is also the basis for determining the basic types and classification of architecture & building systems.

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