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Rational design and construction solutions for the use of the foundations of demolished buildings for further reconstruction

Abstract. The issues of post-war reconstruction of territories and settlements that suffered extensive damage as a result of hostilities are considered. Rational design and construction solutions are proposed that allow maximum use of the foundations of destroyed buildings for further reconstruction. It is determined that the planning solutions for the quarter development of industrial cities are imperfect and require updating in accordance with modern principles. A solution that significantly reduces the amount of work involved in dismantling the underground structures of buildings is to use them for the construction of new reconstruction objects. A combined solution is proposed for the joint use of the foundation array of a destroyed building and a monolithic grillage on bored piles. The use of diamond drilling technologies allows for the effective installation of piles in complex, swampy areas. It is proposed to construct the structure in the form of a system of soil foundation, artificial foundation, connected by a system of piles and foundation frames.

Keywords: city, urban areas, destruction, recycled construction waste, recycling, urban reconstruction, renovation.

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Introduction

The restoration of residential buildings in the destroyed cities and towns of Donbas will pose technical and organizational challenges. The situation is characterized by the scale of destruction—the complete destruction of microdistricts or neighborhoods makes it necessary to determine the order of priority for the renewal of buildings. The technical aspect of the problem lies in choosing a rational plan for clearing the territory. Urban planning documentation and detailed planning projects for microdistricts or neighborhoods operate within a time frame of 2-3 years. If the task of clearing the territory of destroyed objects (buildings) is to be included, this will delay the construction phase for the duration of the cleanup and demolition work. The country has no experience in solving such tasks. The experience of

rebuilding European countries after World War II is also not generally relevant, since the typology of construction solutions at the beginning of the last century had significant differences.

Review of the latest research sources and publications

The experience of post-war reconstruction is always specific and has an object-typological reference. The task of reconstruction is dictated by the general socio-economic situation and directive decisions (concepts) with a political context. Accordingly, it is unrealistic to use the experience of other countries and the results of reconstruction after armed conflicts as direct examples. The analysis of general principles and concepts of recovery, successful or failed regional development programs is of unconditional scientific interest. Caution

against fundamental misguided decisions is an important aspect of defining recovery tasks, models, and approaches.

The Marshall Plan and the experience of rebuilding the European continent are now history. The experience of rebuilding the Balkan countries after the collapse of socialist Yugoslavia is less relevant, as the scale and conditions of the conflict are incomparable. Ukraine is responding to the challenges of the times by introducing legislation to regulate issues and problems of reconstruction [1-3]. It should be noted that the war is not over, the destruction is growing every day, and even the parameters recorded from various sources seem outdated. Unfortunately, the trend toward increasing damage continues [4-6]. The analysis of reconstruction tasks and regional post-war development is the focus of research by many domestic scientists [7-10]. One of the important tasks at the present stage is the problem of managing and utilizing waste generated by the destruction of buildings and structures. A significant number of studies are devoted to this area [11-16]. The tasks of urban development in the context of reconstruction are analyzed in the works [8-10,17].

It should be noted that the factors and conditions that determine the directions, models, and approaches to restoration are the scale of destruction, the level of urbanization of the territory, the level of industrialization of the territory and the density of engineering and technical systems and networks, demographic trends in the region being rebuilt, construction and design solutions for settlements, the presence of significant architectural and cultural heritage, the existence of established state policy on reconstruction, and the presence of a responsible civil society. Equally important are financial and technical resources, both from domestic sources and international assistance.

Problem statement

The aim of the work is the identification and development of rational design and construction solutions that allow maximum use of the foundations of destroyed buildings for further reconstruction in areas of mass destruction of the urban living environment.

Basic material and results

A significant number of districts and microdistricts in Donbas cities have characteristic planning solutions for development. Notable features include linear rows of residential buildings, residential buildings oriented in the same direction, minimal setbacks of building facades (building lines) from street red lines, single-lane intra-quarter roads (3-3.5 m wide), the minimum distance between adjacent buildings allowed by building codes, and the absence of public green areas within the development (Fig. 1).

Fundamental questions arise concerning the order and method of cleaning up areas of mass destruction (Figs. 2, 3).

The clearance of destroyed areas can be organized using heavy construction equipment such as bulldozers, excavators, hydraulic shears, and hydraulic wedges.



Figure 1 – Typical layout plans for densely built-up neighborhoods

The methods and model for clearing destroyed areas constitute a separate scientific and practical task and require additional research [7-10]. Considerable attention is paid to the problem of secondary use and management of construction waste generated as a result of hostilities [11-15]. The problem of dismantling and demolishing the underground parts of destroyed buildings appears to be even more technically complex. In fact, zero cycle works are being reproduced in reverse order with the whole complex of local uncertainty factors. The volume of dismantling/demolition works is significant, as is the volume of earthworks. A solution that significantly reduces the amount of work involved in dismantling the underground structures of buildings is to use them for the construction of new reconstruction projects. A combined solution is proposed for the joint use of the foundation array of the destroyed building and a monolithic grillage on bored piles. It is advisable to drill the existing foundation array using a diamond drill bit in the concrete array (Fig. 4).

The basement space should be filled with recycled waste from dismantled wall structures of the above-ground part with mechanical compaction. The pile spacing and configuration of the pile axes are determined by the dimensions of the planned building. The use of diamond drilling technology also makes it possible to obtain cores – samples of the foundation soil for laboratory determination of physical and mechanical characteristics.

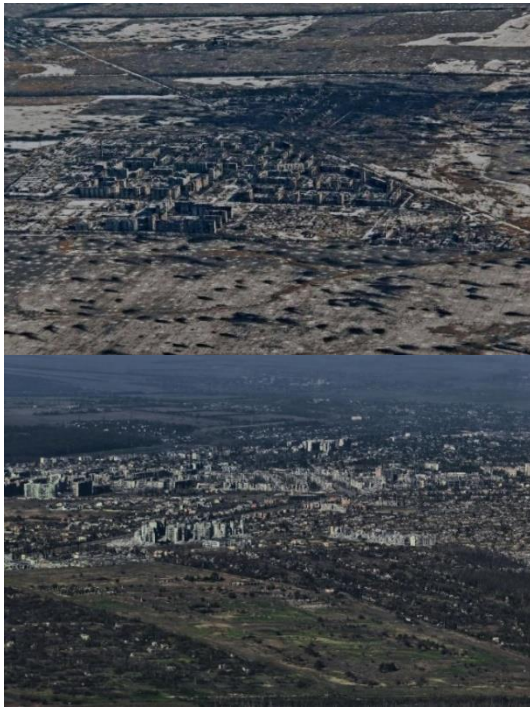


Figure 2 – The exterior appearance of the destroyed city



Figure 3 – The exterior of the destroyed building

The array of laboratory data on soil characteristics will enable high-quality modeling and calculation of the structure-soil foundation system. In conditions of dense development, including areas of destruction and the absence of undeveloped areas, the proposed method of constructing the foundation part is capable of providing high technical and economic efficiency.

Neighborhoods with dense urban development consisting of early mass-produced buildings are characterized by irrational planning solutions that limit the possibilities for reconstruction. Closed development, a building line that coincides with red lines, minimum distance between buildings, and sections arranged in a line. It is not advisable to reproduce (copy) such a planning solution. Figure 5 offers a concept for the reconstruction of a building with an extension and a change in its functional purpose.



Figure 4 – Drilling for built-in-place pile piles using a diamond drill machine

A combined solution of shared use of the foundation array of the destroyed building and a monolithic grillage on bored piles also allows for a reasonable increase in the number of floors of the new building.

The tested approach consists of a partial extension, superstructure using the existing object, including a change in its functional purpose. Within the block, it is possible to maintain the normative population density (person/ha), but to implement free architectural planning solutions and choose a rational number of floors for buildings [17].

This makes it possible to conveniently combine residential properties with public facilities within the neighborhood. The monofunctional type of development is changing to a multifunctional one with all the advantages of such a solution.

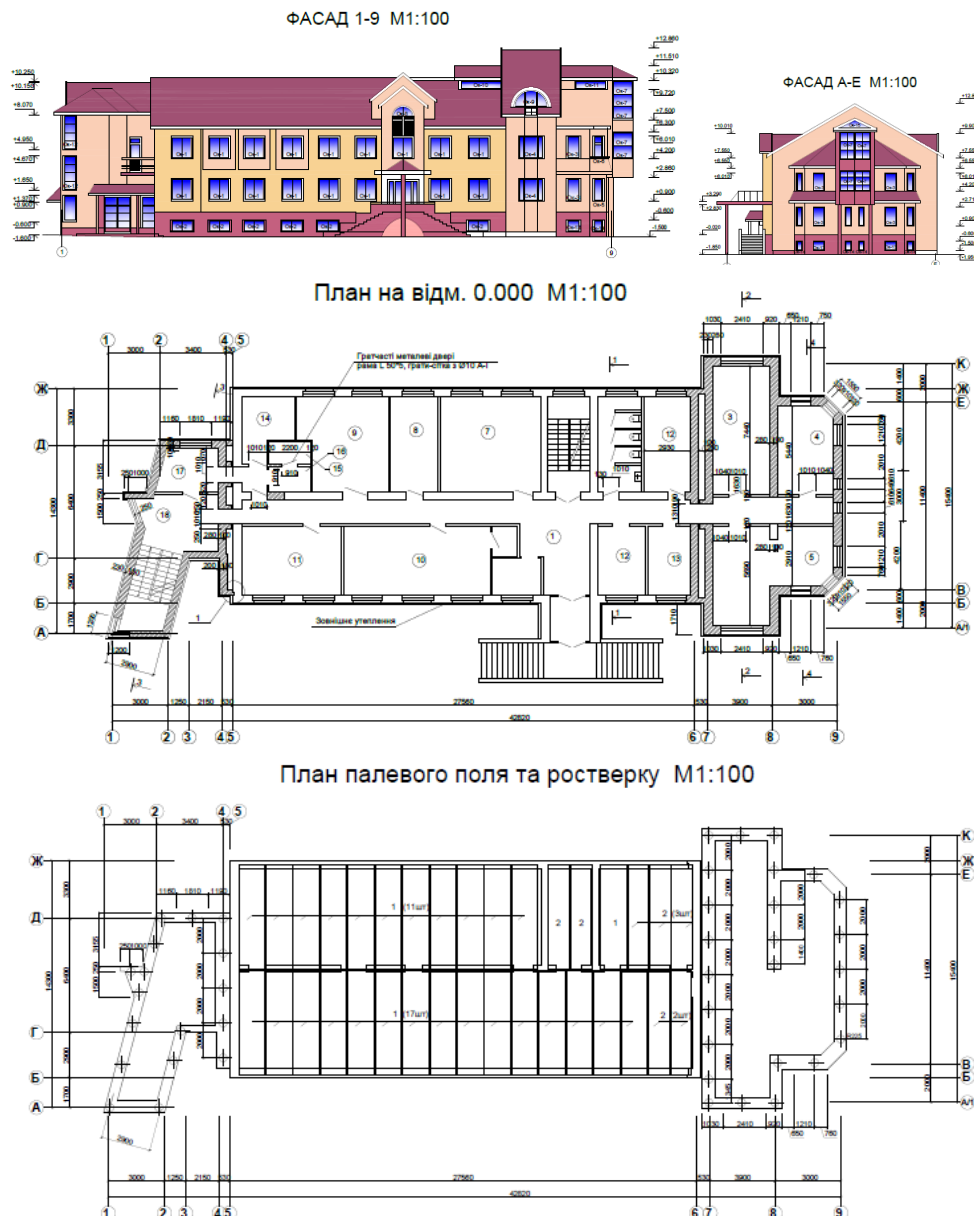


Figure 5 – Conceptual planning solution for the reconstruction of a building with an extension and change of functional purpose

Conclusions

The process of restoring liberated cities will have its own atypical differences. Large amounts of waste are generated in areas of massive urban destruction, and disposing of this waste is a complex and costly problem. It is essential to reduce transportation costs for moving secondary construction waste from

destroyed buildings. A rational option may be to layer waste consisting of mineral materials when forming building sites (blocks). The structure is proposed to be formed as a system of soil foundation, artificial foundation, connected by a system of piles and foundation frames.

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Раціональні проектно конструктивні рішення використання основ зруйнованих будинків для подальшої відбудови

Анотація. Розглянута проблематика післявоєнного відновлення територій та населених пунктів, що зазнали масштабних руйнувань внаслідок бойових дій. Запропоновано раціональні проектно конструктивні рішення, що дозволяють максимально використовувати основи зруйнованих будинків для подальшої відбудови. Визначено, що планувальні рішення квартальної забудови індустріальних міст є недосконалими, та вимагають оновлення за сучасними принципами. Рішенням, яке дає змогу значно скоротити обсяг робіт по розбиранню конструкцій підземної частини будинків є варіант їх використання для зведення нових об'єктів відбудови. Пропонується комбіноване рішення спільного використання масиву фундаменту зруйнованого будинку та монолітного ростверку по буронабивних пальях. Використання технологій алмазного буріння дозволяє ефективно виконувати роботи по улаштуванню паль на складних, замічених ділянках. Конструктив пропонується утворювати у вигляді системи ґрунтова основа, штучна основа, об'єднаних системою паль та ростверком.

Ключові слова: місто, урбанізовані території, руйнування, вторинні будівельні відходи, рециклінг, містобудівна відбудова, реконструкція.

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