SECTION 6. CONSTRUCTION AND CIVIL ENGINEERING

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6.1 Modernization of an existing industrial building

Historical urban development models in Ukraine were largely shaped by the industrialization processes of the twentieth century, which presupposed the territorial relocation of large-scale production clusters to the periphery of settlements. This spatial principle was not accidental: it made it possible not only to minimize the environmental impact on residential quarters and reduce the risks associated with technogenic pressures, but also to optimize logistical connections related to transportation, raw material deliveries, and shipment of finished products. At the same time, peripheral placement created conditions for the unobstructed expansion of industrial capacities in the event of economic growth. As a result, entire industrial zones were formed with autonomous transport infrastructure, independent engineering systems, organized production areas, and a clearly defined functional structure that existed in relative isolation from the residential part of the city. However, dynamic socio-economic transformations, the economic restructuring that followed independence, and later deindustrialization processes contributed to the gradual downsizing or complete shutdown of many industrial enterprises. This led to the emergence of a significant number of inactive industrial territories that ceased to perform their strategic role in the local economy.

Over recent decades, Ukrainian cities have experienced intensive growth, incorporating formerly peripheral districts that are now situated within active urbanization zones and have become fully integrated elements of the urban fabric. Industrial sites once designed at a substantial distance from residential development gradually merged with the expanding urban structure as city boundaries naturally widened. A large portion of these areas lost their primary function and transformed into neglected zones characterized by disrupted spatial organization, fragmented building patterns, and significant physical and moral deterioration of structures. They often contain derelict industrial buildings, irregular infrastructure remnants, and vast vacant plots.

At the same time, contemporary urban planning trends indicate that these very territories hold substantial potential for urban development. Abandoned industrial sites are increasingly viewed as unique resources for establishing new functions—residential, commercial, cultural, educational, recreational, or mixed-use. Their revitalization has become one of the most effective tools for restructuring the urban environment, enabling the creation of strategically important urban clusters: innovation parks, research and educational centers, creative districts, cultural complexes, and multifunctional spaces capable of supporting a wide range of urban processes. Such transformations foster social integration, economic growth, the development of small and medium-sized enterprises, and the formation of a new urban identity for local communities. In this context, the redevelopment of industrial areas is perceived not merely as a simple change of functional designation but as a systemic rethinking of the architectural and planning structure of the territory, including the creation of new pedestrian routes, public open spaces, landscaped areas, and human-centered environments.

A particularly important component of modern revitalization approaches is the rational use of existing resources. A significant part of the engineering and utility networks built in industrial zones was designed with substantial reserve capacity to meet the demands of large-scale production. This includes water supply systems, sewer networks, electrical grids, heat distribution lines, gas pipelines, freight transport nodes, industrial access roads, and rail branches. After the closure of industrial operations, this powerful engineering framework becomes effectively liberated, creating unique preconditions for placing new facilities without the need for large-scale upgrades or excessive infrastructural burdens. In many cases, these networks remain technically suitable for modernization, which significantly simplifies the integration of new functions into the urban fabric and minimizes additional transportation and engineering loads.

Territories of idle factories and plants open up broad prospects for their transformation into multifunctional, integrated complexes (so-called brownfields). Instead of monotonous production zones, dynamic centers with various functions may appear:

- social infrastructure: children's and youth creative centers, educational hubs;
- culture and art: modern exhibition galleries, art spaces, theater studios, industrial heritage museums;
- business and innovation: office centers, coworking spaces;
- housing: loft apartments and other comfortable housing, harmoniously integrated into the historical context;
- sports and recreation: sports complexes, skate parks and extreme sports grounds, recreation areas.

The implementation of such scenarios of adaptive reuse and comprehensive renovation not only improves the quality of life of citizens, but also stimulates domestic tourism (due to unique architecture and cultural content) and, importantly, attracts private investors, contributing to the overall economic growth of the region.

The main architectural and urban planning aspects and challenges in the revitalization of industrial areas are a complex task and include:

- preservation of Historical Identity. A key aspect is to preserve the authentic character of industrial architecture. Old workshops, factory pipes, railway tracks - all this is part of the cultural heritage of the city. It is necessary to develop methods that allow integrating these industrial artifacts into a new functional scheme, emphasizing the contrast between the austere past and modern content. This can be achieved through the preservation of load-bearing structures, facades and the use of industrial elements in interior design and landscaping;
- ecological sanitation. One of the greatest technical challenges is the decontamination and ecological remediation of soils and groundwater that may be contaminated with heavy metals, petroleum products, or chemicals resulting from years of industrial activity. This requires complex engineering solutions and significant

financial investments, but is a prerequisite for creating a safe residential or recreational environment;

- creation of a new spatial planning structure. It is necessary to rethink the existing planning structure of the industrial zone. Usually it is focused on technological processes, rather than on a human-centric organization of space. The task is to create an accessible, pedestrian, inclusive environment with a clear system of public spaces, green areas and effective transport logistics that integrates this area into the overall urban fabric. This includes the development of new highways, cycle paths and connections to public transport.

Revitalization of industrial areas is not just the reconstruction of buildings, but a complex urban development process that requires a multidisciplinary approach and is a key element in the formation of a healthy, sustainable and competitive modern city.

The article describes an example of changing the functional purpose of a production building through reconstruction.

It was necessary to develop structural solutions to change the existing high-rise single-story manufacturing space into a three-story office building with a roof terrace.

To achieve this goal, a detailed survey of the existing building was conducted.

The surveyed part of the building is for industrial purposes, with dimensions in plan of 17.5x18 m in axes 1-2, A-B.

The height to the bottom of the covering slabs is 7.8 ... 9.62 m. The height to the bottom of the covering trusses is 6.99 m. The height to the bottom of the floor in axes 2-4, A is 3.0 m.

Along axis 4, the building is adjacent to a frame administrative building, along axes 1 and B, there is a production part, which is structurally similar to the part of the building under investigation. The plan of the first floor of the part of the building being reconstructed is shown in Figure 1, and a section of the building is shown in Figure 2, and a photo of the existing facade of the building is shown in Figure 3 (all the drawings mentioned are the author's own designs and photos).

The rigidity of the building in both directions is provided by reinforced concrete columns clamped into the foundations, reinforced concrete roof trusses, wall panels, brick enclosing walls, and a horizontal disk of roof slabs.

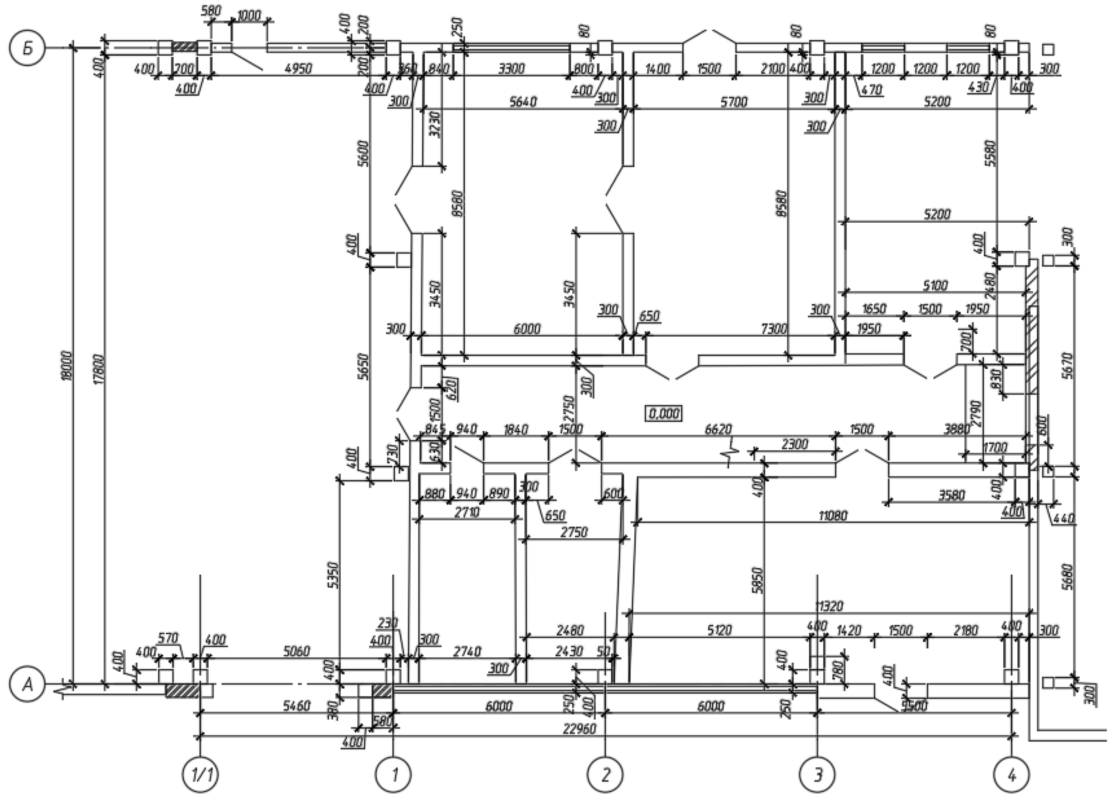

Figure 1. First floor plan [made by the authors]

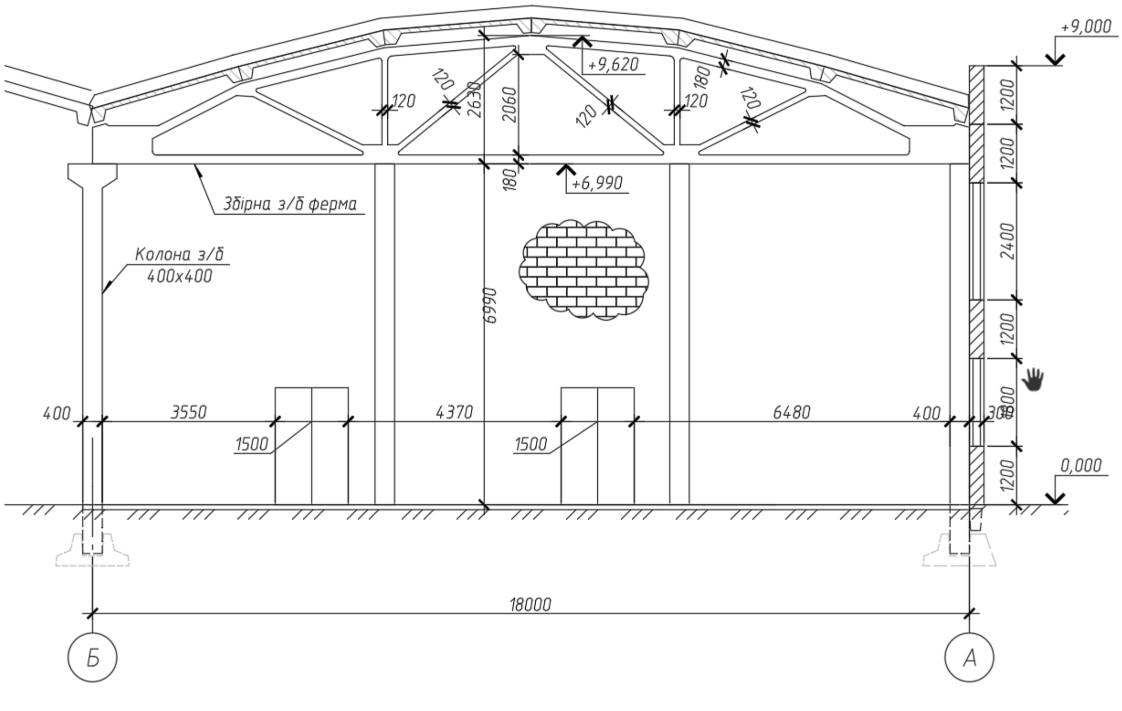

Figure 2. Section through the building [made by the authors]

Figure 3. Existing building facade before reconstruction [made by the authors]

During the inspection of the facility, photo-fixation of defects in structural elements was performed, as well as means for checking the geometric dimensions and condition of the building elements.

As a result of the inspection of the structure, the following was established:

- foundations for the frame columns - columnar reinforced concrete of the careful type;
- foundations for brick walls - prefabricated reinforced concrete foundation beams on columnar foundations;
- columns - prefabricated reinforced concrete;
- roof trusses - prefabricated reinforced concrete, length 18 m, height in the center 2.63 m;
- roof slabs - prefabricated reinforced concrete ribbed 3x6.0 m and 1.5x6.0 m (h = 300 mm);

- external walls - prefabricated expanded clay concrete wall panels, made of ceramic bricks;
- internal walls - ceramic bricks;
- partitions - ceramic bricks;
- lintels - metal;

In general, the following were recorded in the internal and external volume of the building:

- damage to the protective layer of concrete of reinforced concrete columns with exposed reinforcement, corrosion of reinforcement;
- corrosion of embedded parts of columns;
- traces of sealing of covering slabs in places of passage of deflectors, fungal damage, unsealed seams between covering slabs
- fungal damage to walls;
- vertical cracks in brick walls;
- corrosion of embedded parts of wall panels;
- unsealed seams between wall panels;
- exposure of brickwork
- traces of sealing of covering slabs in places of passage of deflectors, fungal damage;
- traces of sealing of wall panels;
- cut out part of reinforcement of wall panel;
- vertical cracks in wall panels;
- knocked out through hole in monolithic beam with exposed reinforcement;
- crack in monolithic ceiling;
- exposed brickwork;
- corrosion of metal lintels;
- damage to the blind area.

According to the results of the survey, the following conclusions were made:

1. The structure under investigation is in satisfactory (2) condition.
2. To enable the reconstruction of the building, it is necessary to:

- implement a project to strengthen existing structures;
- strengthen or dismantle the wall that is in a state of emergency;
- clean the column reinforcement from corrosion, restore the protective layer of concrete;
- cover the embedded parts of columns and wall panels, metal lintels with anti-corrosion and clean them with metal brushes from corrosion products, paint;
- fill, clean and restore the destroyed seams between the wall panels;
- seal the seams between the ribbed panels of the coating;
- carry out finishing works;
- restore the blind area.

3. According to the results of engineering geological research and preliminary calculations, it is possible to reconstruct part of the production premises in axes A-B and 1-4 for administrative and domestic premises on two full floors with an attic floor in the space between reinforced concrete trusses.

To do this, it is necessary:

- to create an internal grid of columns (as an option 6x6 m);
- the foundations for the new columns should be made of small-diameter bored piles with an expanded lower end of the pile and support in the IGE 3 or IGE4 soil, according to geological surveys (see Appendix D);
- it is possible to use glass-type foundations for the new columns with their support in the IGE3 soil and the implementation of measures to ensure the integrity of the thixotropic soil structure during the work;
- it is recommended to use monolithic reinforced concrete floors as two new floors;
- the need to strengthen the foundations of the existing frame columns should be established by the working design, taking into account the possibility of dismantling heavy partition walls and replacing them with lighter ones.

A photo of the existing interior of the building is shown in Figure 4 (this is the author's photo of the authors of the article).

Figure 4. Photo of the existing interior of the building [made by the authors]

The reconstruction project involves a deep rethinking of part of the existing industrial building, originally formed as a single-storey volume with a significant floor height, which was characteristic of the production processes of past decades.

The spatial structure of this type of facility - with large spans, high light levels and simplified internal organization - creates a natural potential for further transformations, especially in cases where the functional purpose of the building changes.

The preliminary technical survey confirmed that the load-bearing structures have retained the necessary level of reliability, which allows for reconstruction measures and the integration of new elements without the risk of violating the overall structural stability of the facility. One of the key architectural and structural solutions was the justification of the possibility of transforming a large single-level production hall into a three-storey structure with new horizontal levels.

The high elevation of the existing roof and the absence of internal capital partitions provided sufficient spatial resources to form several independent floors with their own planning configurations. The modified designed plan is shown in Figure 5 (the drawing is the author's own work.).

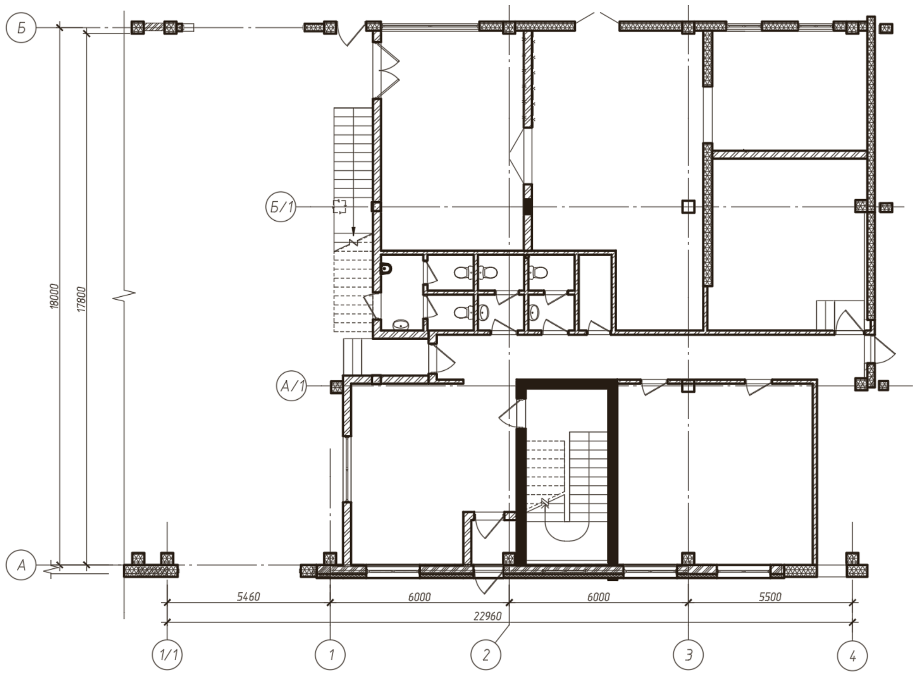

Figure 5. New building plan [made by the authors]

The project involves the installation of new interfloor ceilings, the geometry and location of which take into account the optimal distribution of loads on the existing frame and ensure stable operation of the structural scheme after its modernization. The integration of new structural elements is carried out in such a way as to preserve the maximum possible volume of the existing building, avoid its excessive dismantling and ensure the economic feasibility of the reconstruction.

The designed section of the building is shown in Figure 6 (the drawing is the author's own work.).

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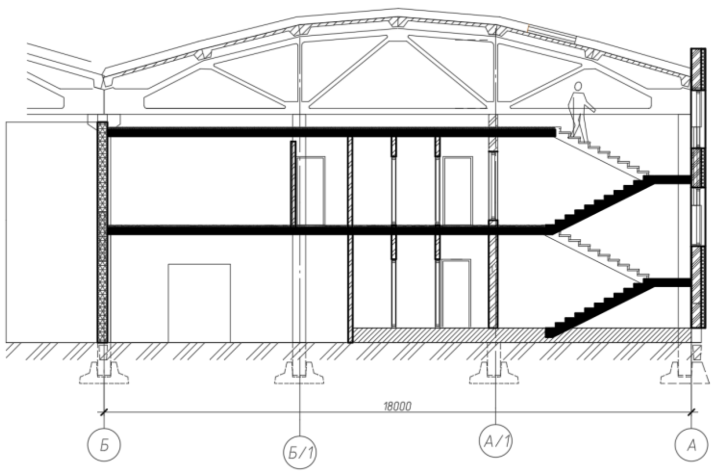

Figure 6. Projected section of the building [made by the authors]

The formation of the internal space of the future three-level structure is based on the principles of rational use of space, the creation of a logical spatial hierarchy and ensuring the architectural integrity of the object. The design proposal provides for clear functional zoning: the organization of the main premises on the middle and upper levels, and auxiliary or communicative zones on the lower, which allows for the effective use of every square meter of space. Particular attention is paid to the formation of the corridor system, the proportions of the premises, the interconnection of open and isolated areas, as well as ensuring the natural logic of movement between different parts of the building. The significant height parameters of the existing space allow for the implementation of various architectural scenarios: from the formation of full-fledged separate floors to the creation of partially open spatial compositions, inter-level visual connections and double light spaces in selected areas.

The reconstruction also involves adjusting the volumetric and spatial composition of the building. Given that the initial volume of the industrial building was focused on supporting technological processes, its plasticity was minimalist and utilitarian.

Figure 7 (this is the author's photo of the authors of the article) shows the result of dividing the internal space of the building into three levels after performing monolithic works on the arrangement of new columns and floors.floors.floors.

Figure 7. Implementation of division into three parts of the internal space [made by the authors]

The new function, which involves administrative and domestic use, requires a different character of the architectural environment - with increased attention to the proportions of the facades, western groups, natural lighting and harmonization of the exterior of the building with the surroundings. The project involves rethinking the facade structure by arranging the openings, restoring or replacing window systems, as well as adjusting the plasticity of the external walls to form a more expressive and modern architectural image..

Figure 8 (this is the author's photo of the authors of the article) shows the modified facade of the building (at the time of taking the photo, the facade decoration had not yet been completed).

Figure 8. Changed building façade [made by the authors]

In the structural aspect, an important part of the work is the analysis of the interaction of new and old elements. Since the original building was created for production needs, its structures had a significant margin of safety, which today allows the integration of additional floors and local reinforcements without increased risks. The project provides for minimal intervention in vertical load-bearing elements, with an emphasis on local reinforcement in places of concentration of vertical and horizontal loads. This approach allows preserving the structural authenticity of the building, while ensuring its compliance with modern requirements for reliability and durability.

Also, Figure 8 shows that during the works, access to the roof of the building was organized, where a large terrace with the possibility of arranging a recreation area was designed. A photo of the roof at the location of the terrace is shown in Figure 9 (this is the author's photo of the authors of the article).

Figure 9. Roof at the terrace location [made by the authors]

Reconstruction of part of an industrial building for a new administrative and residential function is a complex architectural and structural process that includes the adaptation of a single-level large-space volume to the format of a full-fledged three-level structure. Thanks to the high initial structural quality of the building and competent design solutions, it was possible to form a modern, functionally rich and spatially balanced architectural object that meets the current requirements of adaptability and effective use of existing construction resources.

The analysis justifies the possibility of changing the functional purpose of the production workshop to a full-fledged office complex using the spatial reserves of the building, improved structural schemes and preserving part of its architectural heritage. The implementation of such reconstruction approaches contributes to:

- optimizing the use of urban areas;
- saving resources and infrastructure costs;
- forming new centers of business activity;
- increasing the architectural and spatial attractiveness of the city;
- preserving the historically formed industrial environment..

The given example of reconstruction confirms that the reconstruction of existing industrial enterprises is a strategically important process for the development of cities, and professionally executed constructive and architectural solutions allow the creation of high-quality, functionally flexible and architecturally expressive objects based on existing industrial development.