INTERNATIONAL JOURNAL OF CONSERVATION SCIENCE
ISSN: 2067-533X Volume 16, Issue 3, 2025: 1261-1272 www.ijcs.ro
DOI: 10. 36868/IJCS.2025.03.03

RENOVATION OF A POST-INDUSTRIAL BUILDING AND CHANGE OF ITS UTILITY FUNCTION

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Abstract

Owners of historic buildings whose technical condition is unsatisfactory must make a decision about their future. These buildings were built at a time when requirements regarding their functionality were different than today. In order for them to be used, they must be renovated, and the elements that have undergone degradation must be restored. This process is often accompanied by a change in the utility function that allows the building to be used in the current economic realities. This paper presents a methodology for the decision-making process regarding the scope of renovation and reconstruction works on historic buildings, taking into account their new utility program. An example of the renovation of a two-story post-industrial building located in Częstochowa was presented, for which its previous utility function was changed. When adapting the building to new operational requirements, the assumption was made to preserve the existing substance of the building to the greatest extent possible while meeting all structural conditions. It was assumed that most of the visible architectural and construction elements referring to the original character of the building would be restored. The scope and justification for performing individual renovation and reconstruction works are discussed. It has been shown that the applied methodology allows for rational adaptation of the building to current operational requirements while maintaining its original, historic character to the greatest extent possible.

Keywords: *Post-industrial Buildings; Historical Buildings; Renovation Works; Change of Utility Program*

Introduction

Industrial buildings of a historic nature constitute a valuable historical heritage documenting the industrial and economic development of a given region. They are a valuable source of information on which branches of the economy developed over the years. They are also material examples of architectural and construction solutions used in the past in a given area.

Historic buildings from the turn of the 19th and 20th centuries are most often associated with religious (churches), residential (tenement houses, residences, palaces), or public utility (railway stations, schools) objects [1]. Historic industrial objects are often treated as less important from the point of view of cultural and historical heritage [2]. They include factory buildings with accompanying buildings [3], industrial installations [4], or industrial infrastructure objects [5]. These facilities were mostly built on the outskirts of the then urban areas. However, as a result of the progressive expansion of cities, their location has now become very attractive,

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which is undoubtedly a factor encouraging potential investors to consider the decision to renovate them. Transforming post-industrial buildings into new functional spaces – commercial [6], sports [7], or educational [3] – influences the change of the socio-cultural environment and increases the economic attractiveness of not only the renovated property itself but also the neighboring areas. An example of successful revitalization of post-industrial buildings on a city-wide scale is Łodz (Poland), where numerous historic buildings related mainly to the textile industry have been adapted to new utility functions, e.g., retail and services objects ("Manufaktura" Shopping and Entertainment Centre), buildings used for educational and research purposes (University Campus of Lodz University of Technology) [3], or for residential purposes.

Activities related to the renovation of industrial facilities, although generally enjoying great social support, sometimes lead to conflicts between individual stakeholders (state authorities–developers, developers–local community) [8]. Therefore, it is necessary to seek solutions that will not jeopardize the interests of individual groups in the renovation process. Social awareness related to the need to protect cultural and historical heritage is constantly growing. Where it is the greatest, organizations and associations are established whose goal is, on the one hand, to educate residents of areas that are to undergo revitalization, and on the other hand, to influence local authorities to introduce solutions that facilitate the undertaking of activities related to the renovation of post-industrial facilities.

The creation of industrial infrastructure is closely linked to the economic development of a given region. In the case of Częstochowa, the precursors of industrial plants were factories, mainly textile ones. The dynamic development of industry associated with the creation of new factories took place at the turn of the 19^{th} and 20^{th} centuries. The following plants were established at that time: Częstochowa Steelworks, La Czenstochovienne Spinning Society, Wulkan Foundry and Enamelling Plant, W. Kohn i Oderfeld Printing House, Gehlig i Huch Match Factory, K. Szwede Brewery, A. Ginsberg i Kohn Paper Factory, and other industrial plants. The industry was based on the use of steam engines, and the first electrical station launched in 1887 was intended to generate electricity for street lighting.

The development of industry also influenced the development of the city. Around large factories, service workshops, warehouses, and residential buildings for employees and their families were built. Over time, some of these buildings lost their functionality and were demolished. Those that survived often require renovation and major repairs, which involves the need to incur significant financial costs.

When renovating a given object, a decision must be made as to the function it is to fulfill in the future. This may be a non-commercial function (e.g., museum), which is most common in the case of objects with institutional owners. A certain problem in such a case is obtaining sources of financing for renovation and subsequent maintenance of the object. Therefore, it is reserved for objects of great historical value.

In terms of ownership of historic properties, the largest group is private owners [9]. The obstacles they encounter during renovation work include financial barriers (lack of sufficient funds) and legal problems (including those related to obtaining the required consents and permits for functional changes) [10]. A certain way to overcome financial barriers is to obtain an external source of financing. In some countries, there are special government programs supporting activities related to the revitalization of post-industrial buildings [11], but usually the costs related to their renovation are covered by the owners. In the case of private owners, the best solution to save the building is to find a new commercial function for it. Thanks to the future income generated by such facilities, their owners are able to invest their own funds to carry out renovation work. Such a solution also guarantees a constant inflow of funds to cover current operating costs and to perform the work necessary to maintain these buildings in proper technical condition.

An important factor before making a decision on preserving a building is to assess its technical condition and to determine the scope and method of conducting renovation works, taking into account the adaptation of the building to new conditions of use. The condition of historical monuments in Poland is not satisfactory; only 9% of buildings do not require renovation works. For industrial buildings, this value is even lower and amounts to 7% [9]. The remaining ones require minor repairs, protective measures, or major renovations.

When working on a renovation project for old post-industrial buildings, it is necessary to take into account not only the original architectural style of the era in which the building was constructed but also to create a solution that meets current functional requirements [12]. This applies to both structural issues, e.g., modernization of ceilings in order to adapt them to new utility requirements [13], and those related to ensuring the energy efficiency of the building after the renovation process is completed [14, 15].

This paper analyzes the methodology of the renovation process of a post-industrial building located in Częstochowa, whose original warehouse and production function was changed to a workshop and office function.

Materials and methods

The methods of field survey and analytical evaluation were used. Thanks to field research, the technical condition of the facility was diagnosed. Elements requiring restoration, reconstruction, or replacement were identified. The information was supplemented by performing an inventory of the facility. Based on the analytical assessment, the scope of renovation works necessary to be performed was determined.

The following criteria were adopted:

1) preserving the existing substance of the object as much as possible,

2) reconstruction of visible architectural and structural elements to a degree that allows the preservation of the original character of the building,

3) meeting construction requirements,

4) meeting the operational requirements for the new utility function of the facility.

A methodology was developed for the decision-making and implementation process regarding the renovation of historic buildings, combined with their adaptation to a new utility program.

Results and discussion

The history of the building

The building in question is located in Częstochowa on the border of the Stradom and Ostatni Grosz districts. The surrounding buildings are of an industrial and service nature. The oldest of them date back to the turn of the 19^{th} and 20^{th} centuries. Due to the lack of documents regarding the initial period of the building's existence, it is impossible to clearly determine its original nature. It is known that food processing plants were located in this area at the beginning of the 20^{th} century. Considering the functional layout of the building, the layout of individual rooms, their dimensions, and the functions of the neighboring buildings, it can be risked to say that this building served a production and storage role related to the above-mentioned business profile. In the post-war period, the nature of production did not change, and the building became part of state-owned plants dealing with food processing and distribution. During this time, the building underwent some modifications, completely ignoring the original architectural assumptions. The window openings on the first floor were partially bricked up, their original arched shape was replaced with a rectangular one, and the layout of the internal partition walls was also changed. The window and door joinery was replaced with the one used at that time, and a new roof covering was laid. After a period of political changes (1990s), the previous owner went bankrupt, and the plant buildings were subject to devastation and slow destruction. After some time, the plant area together with the buildings was divided into several parts and then sold to new owners. Each of them had to make a decision regarding the future of the purchased property - demolish the existing buildings and use the attractiveness of this area to erect new buildings that meet current utility standards or undertake their renovation. In the case of the analyzed building, the latter option was chosen. Thanks to this, the historic character of the building was preserved, being an example of small-scale industrial development from the turn of the 19th and 20th centuries, characteristic of the beginnings of the city's industrial development.

Condition of the building before renovation

The building has a rectangular shape in plan with dimensions of 47.26×8.37m, its height at the ridge is 8.14m. It has a two-slope roof with a slope of 31.3% with a mansard in the central part of the building. The building consists of two stories (upper and lower) separated by a ceiling. In the central part of the building there is a staircase (two-flight reinforced concrete stairs) with a landing halfway up. Wooden beams were anchored in the longitudinal walls of the upper story at a spacing of approx. 1m, securing the walls from tilting outwards. They also act as a support for the wooden truss located in the ridge, on which the purlins are based (their other end rests on the walls). Full formwork was made on the purlins, to which the roof covering in the form of roofing felt was attached.

Renovation and restoration works

In order to define the scope of possible changes to the building structure during its renovation, an analysis of the formal and legal status of the building and the applicable regulations was carried out. On this basis, it was determined which of the main architectural and structural parameters of the building must be preserved and which will be subject to modification in connection with the need to meet the requirements for the new utility function of the building. The results are presented in Table 1.

Table 1. Analysis of the possibility of changing the basic architectural and construction parameters in the building renovation process in light of formal and legal conditions

Architectural and structural parameters	Possibility to change	Necessity of change for a new utility function	Planned change
Building height	no	no	no
External dimensions of the building	no (*)	no	no (*)
Shape and slope of the roof	no	no	no
Roof structure	yes	no	no
Ceiling structure	yes	yes	yes
Building facade	yes	yes	yes
Load-bearing wall system	no	no	no
Arrangement of operating walls	yes	yes	yes
Stairs	yes	no	no

(*) except for changes resulting from thermal insulation

An inventory of the facility was made, and field research was conducted, based on which the technical condition of the building was assessed using a scale of 1 to 5, where 1 means poor condition and 5 very good condition. An architectural concept for the new use of the building was developed, taking into account the scope of possible changes. The type of planned activities was initially determined in relation to individual structural and non-structural elements of the building (Table 2).

Table 2. Assessment of the condition of individual structural and non-structural elements of the building along with the planned action in the renovation process

The type of element	Assessment of condition before renovation	Planned action		
		Renovation	Repair/strengthening	Restoration
Load-bearing wall system	4	yes	yes	no
Roof truss	4	yes	no	no
Ceilings	1	no	no	yes
Lintels	4	no	no	yes (*)
Foundations	3	no	yes	no
Stairs	4	yes	no	no
Interior plasters	1	no	no	yes
Building facade	1	no	no	yes
Windows and doors	1	no	no	yes
Floors	2	no	no	yes
Roof covering	2	no	no	yes
Roof decking boards	3	no	yes	no
Chimneys	3	no	yes	no
Operating walls	2	no	no	yes

(*) in places where existing door or wall openings are widened

Detailed design documentation was prepared, covering the full scope of renovation and reconstruction works, with the assumption that as much of the original character of the building would be preserved as possible while meeting all the requirements related to its new function. The developed methodology is presented in Figure 1.

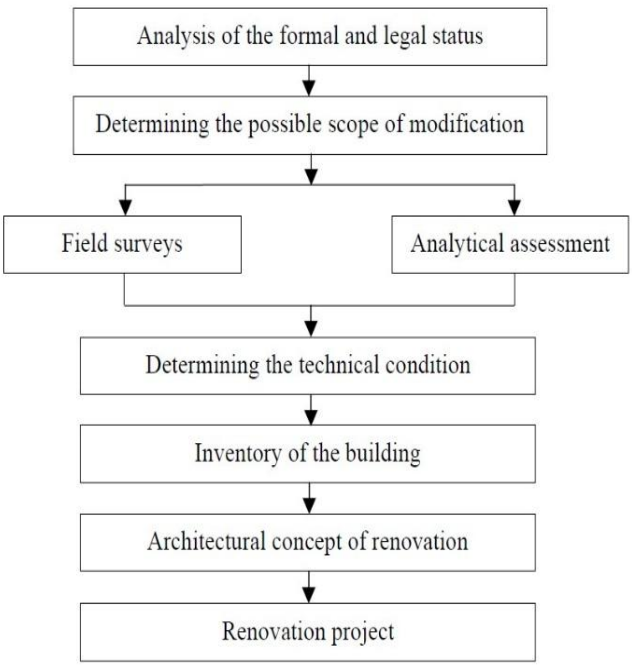

Fig. 1. Methodology of the decision-making and implementation process in the field of renovation of facilities with their adaptation to a new utility program

The most valuable architectural elements emphasizing the historic character of the building, which it was decided to preserve and expose, include the arch-shaped brick lintels above the upper-story windows, the structure of the external walls with the preserved brick layout, and the unique roof truss construction with a wooden lattice truss placed parallel to the ridge, supported by transverse wooden beams anchored in the longitudinal external walls.

Structural elements

The external and internal load-bearing walls, approximately 36cm to 52cm thick, made of solid bricks, were in good technical condition. Locally, there were minor cracks that did not affect the strength parameters of the wall. Minor losses in the mortar connecting the bricks were filled. In order to highlight the historic character of the building, the walls on the internal side were locally cleaned by sandblasting, and a colorless protective coating was applied and left exposed (without applying internal plaster), treating this as an architectural value of the interior design of the building.

The roof truss was made in a truss-purlin structure. The purlins were supported at one end on the wall plate and the other on a lattice truss positioned parallel to the longitudinal axis of the building. The truss was supported by wooden beams embedded in the longitudinal walls, bracing the walls (Fig. 2).

Fig. 2. Existing roof truss structure during renovation

The technical condition of the roof truss was assessed as good; no defects or traces of biological corrosion were observed. Considering the unique nature of the roof structure solution used, the surfaces of individual elements were cleaned, preserved, and covered with a varnish, preserving the structure of the wood. After completing these works, the entire structure was left visible (the suspended ceiling was abandoned), which, combined with the visible structure of the brick wall in places, creates a unique character of the interior, referring to the austere style of industrial buildings from the beginning of the 20th century.

The building ceiling between the first and second stories was made as a semi-heavy Klein ceiling (Fig. 3). Its technical condition was very poor - the corrosion of the ceiling beams was so advanced that it was necessary to dismantle them. Therefore, a decision was made to replace the ceiling also with a beam-slab ceiling (Fig. 4), which would integrate the structure of the existing walls and would have an appropriate load-bearing capacity adapted to the size of the loads expected for future use. A solution in the form of a composite steel-concrete ceiling made on corrugated sheet metal was chosen. A solution of the same type was adopted during the renovation of the historic building of the Wrocław Główny railway station [16].

Fig. 3. Existing building ceiling

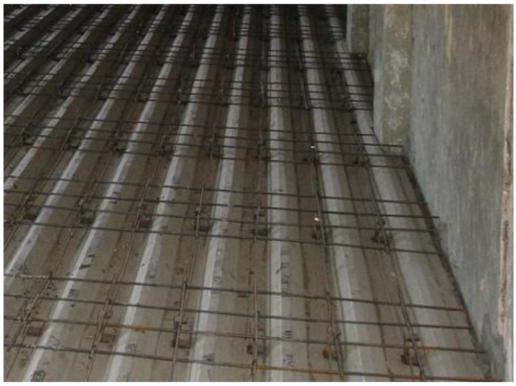

Fig. 4. New composite floor before pouring the slab

The corroded steel I-beams (Fig. 5) were replaced with new ones (Fig. 6), and the brick slab was replaced with a reinforced concrete slab made of corrugated sheet metal. Due to the required usable height of the story for the new function, the key issue was to use a solution in which the height of the steel I-beams would be as small as possible, which translates into a reduction in the structural thickness of the ceiling. Therefore, it was decided to use a solution in the form of a composite steel-concrete ceiling, in which the height of the steel beams was the smallest among all the considered variants.

Fig. 5. Corrosion of existing ceiling beams

Fig. 6. New ceiling beams

The upper-story arch-shaped lintels were made of bricks and were in good technical condition. A decision was made to renovate them and expose them from the inside of the wall. For this purpose, the internal plaster was removed, and the wall surface at the lintel was cleaned and preserved, revealing the brick structure. The lower-story lintels were made of steel sections embedded in the wall at both ends and insulated from the outside (Fig. 7).

Fig. 7. New lintel (strengthening the structure in light of new utility requirements) at the location of the widened existing opening

In places where the existing dimensions of window and door openings were preserved, the old lintels were left. In places where it was decided to widen the openings, lintels in the form of two hot-rolled C-sections placed in grooves carved in the wall and screwed together were used (Fig. 7).

Due to the increased load on the ceiling resulting from the new method of use (weight of new finishing layers, higher than the previous value of the operational load), the foundations were reinforced under the load-bearing walls. The walls were divided into sections of approx. 1.0m in length. After removing the floors, the foundation walls were excavated from the inside and outside on the first section; the exposed part of the wall was undermined by removing the soil from under it, formwork was made, and the first section of the foundation strip was poured. After the concrete hardened, the foundations were insulated and the excavation was filled. These activities were repeated for the next sections, maintaining a distance of approx. 3m between the excavated sections. The foundation strip made in this way was wider than the thickness of the existing walls (Fig. 8). Thanks to this, the load transferred by the walls was distributed over a larger area of the ground, which led to a reduction in stresses at the foundation-subgrade interface and at the same time prevented any possible cracking of the existing load-bearing walls.

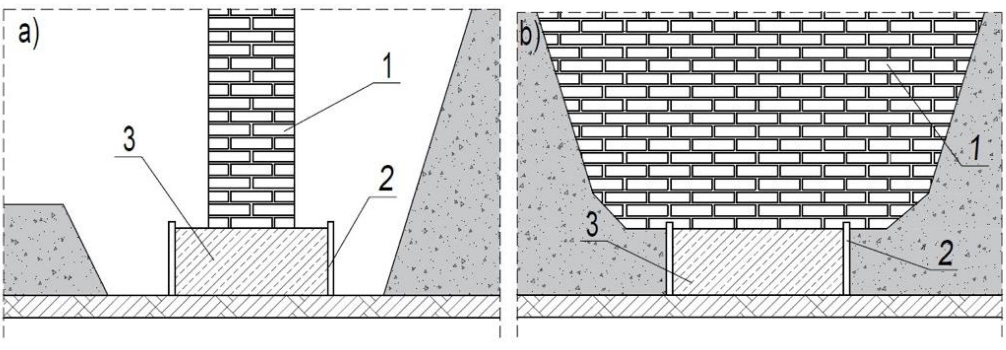

Fig. 8. Method of strengthening existing foundations: a) cross-section, b) longitudinal section, 1 – existing foundation wall, 2 – formwork of the concreted section of the foundation, 3 – section of the new foundation

The building is served by one staircase located halfway along its length. The two-flight stairs with a landing were made of reinforced concrete, finished with a stone cladding, and secured with a metal railing. It was decided to leave them and renovate them.

Non-structural elements

The internal plasters were in very poor technical condition. They were found to be loosening from the walls, with numerous cracks and large unevenness. In addition, due to the need to install a new electrical system, which would interfere with the existing walls, it was decided to completely remove the old plaster and apply a new plaster coat. In some places, exposed fragments of the brick wall were left (after prior cleaning and preservation), which, when combined with the smooth texture of the plaster, constitute an interesting decorative element and also allow for insight into the original historical structure of the wall.

The building elevations were uniform surfaces of external walls. The external cement-lime plasters were cracked, with gaps in some places (Fig. 9). Loose plaster fragments were removed and leveled, and the surface was primed. In order to meet the utility requirements, thermal insulation of the external walls was made together with a new plaster in orange and yellow colors. The shape of the window openings on the second floor was emphasized by making pilasters in a different color than the wall, referring to the original appearance of the building. A bay window with rustications was made in the central part of the front elevation with extensive glazing providing lighting for the staircase (Fig. 10). The plane of the walls of the above-ground part was extended in relation to the plane of the ground floor walls, creating a plinth (setback) protecting the wall from water leaks.

Fig. 9. The front elevation of the building before renovation

Fig. 10. The front elevation of the building after renovation

The window and door joinery was devastated or missing in places. A change in the shape of the windows on the second floor (compared to the original state) was visible – the window openings were reduced, changing their shape from arched to rectangular (Fig. 9). A decision was made to restore their original shape with the division of the window sashes by mullions, referring to the solutions from the era in which the building was built (Fig. 10). The windows on the upper and lower floors were made of wood; the front door and the staircase skylight were made of aluminum. Due to the workshop function of the rooms on the first floor, the height of the window openings was reduced, thus enabling the location of workstations directly at the wall of the building.

The floors of the upper story (due to the replacement of the ceiling) were made anew. Stone and stoneware tiles were used as the top layer. The floors of the lower story were dismantled due to their poor technical condition and lack of horizontal damp-proofing insulation. In their place, new ones were made, finished in the workshop part with industrial flooring, in sanitary facilities, and in communication routes with stoneware tiles.

The roof covering was made of black bituminous felt. Due to high wear (numerous surface undulations and gaps), the existing covering was removed, exposing the roof planking. Damaged planks were replaced, the whole thing was impregnated, and a new covering was made, also of bituminous felt in orange-brown, referring to the colors of the facade. Thermal insulation of the roof was also made in the form of mineral wool. The sheet metal flashings and gutters were also replaced.

The existing chimneys were made of brick, and their surface was finished with plaster. They were renovated by removing loose parts, filling in gaps, making a chimney cap, and applying new plaster in the color of the roof covering.

The partition walls were completely demolished. The new functional layout was separated using new walls, partly brick and partly made of plasterboard.

The final effect of the renovation and restoration works is shown in Figure 11.

Fig. 11. The final effect of the renovation works carried out

Conclusions

Finding a new commercial function for devastated post-industrial facilities is one way to save them. This preserves not only the architectural structure of the facility but also the history of the place it is associated with.

The renovation and reconstruction works carried out allowed the analyzed building to be saved from demolition and the basic structure of the building to be preserved while meeting current operational requirements. The commercial utility function that the building fulfills after renovation allows for a successive return on the incurred costs and also covers current operating costs.

When developing the renovation project, the need to improve the building's current energy efficiency was taken into account. Solutions that enable energy savings and reduced emissions were selected.

The methodology used in the decision-making and implementation process for the renovation of historic buildings allows for rational adaptation of the building to current operational requirements while preserving its original, historic character to the greatest possible extent.

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Received: January 10, 2025
Accepted: July 10, 2025