CIVIL AND ENVIRONMENTAL ENGINEERING REPORTS

No. 9 2012

RENOVATION AND MODERNISATION OF A POSTINDUSTRIAL FACILITY IN POZNAŃ

Tomasz BŁASZCZYŃSKI*, Przemysław WIELENTEJCZYK,
Maciej BŁASZCZYŃSKI, Filip PIJANOWSKI
Institute of Building Structures, Poznań University of Technology

The paper presents a renovation process of a historic postindustrial building situated on premises of Gazownia Poznańska. An unprepared team of designers made a lot of mistakes and negligences, which led to additional work, repairs including. The increased scope of work also led to a substantial increase in the cost of the carried out renovations. The modernisation process was realised with the use of modern technologies, some of which for the first time in Poznan.

Keywords: renovation, modernisation, jet-grounting, helifix, SCC

1. INTRODUCTION

Renovation and modernisation projects of old building substance may well contribute in satisfying urgent social needs by providing new functions [1]. Structures of old industrial buildings, unlike modern manufacture facilities, were made of durable materials. Thus, in terms of basic principles of sustainable development: *"...current use of the heritage resources does not nullify the chance to pass them to future generations ..."*[2], it is possible to fully exploit them while integrating as elements of modern facilities. The example of such reasoning is revitalisation of one of the oldest gas tanks in Europe, which resulted in converting it into service and commercial facilities [3, 4]. Facilities of various use, from office buildings [5] to industrial chimneys [7], are subject to revitalisation. A multifunctional historic building is an interesting example of such adaptation [6]. However, in all these cases, the most important element is the future durability of these objects [8, 9].

* Corresponding author. E-mail: tomasz.blaszczynski@put.poznan.pl

2. DESCRIPTION OF THE MODERNISED BUILDING

Dressing room – Bath (Szatnia–Łaźnia) house, which was subject to adaptation and extension, had been erected at the beginning of 20th century in the style of industrial architecture. With a architectural brick detail, it refers to buildings in the northern part of Gasworks. The property was built probably in the late nineteenth century or early twentieth century, as a four floor traditional structure with a basement (fig. 1, 2). Practically, no technical documentation was found on the basis of which the project could have been realised. Initially, the analysed facility was intended to be a paper products factory for Cohn and Sieburth company, which can be seen on the letterhead with a date 1908 on it (fig. 3). Later, the property became the possession of the gas plant and the building was designed as the Dressing room – Bath facility. The dressing room and bath have remained on the ground floor to this day, on the subsequent floors there is a lounge, various rooms and the archive. In the inter-war period, the cellars were converted into the air-raid shelter and a tunnel was built which connected the Dressing room – Bath building with the building of the Gasworks Directorate.

Fig. 1, 2. Dressing room - Bath house before modernisation, the front and back views

In probably 1973, after 117 years of operation, the Gasworks was extinguish, there was Koppers' boiler building in immediate vicinity of analyzed building. After the war damages, Koppers' boiler building was rebuilt and in the 50s expanded (fig. 4, 5).

On the north side of the dressing room-bath building, there was a wagon discharger where wagons of coal were emptied and then the coal was transported to the boiler room on conveyor belts (fig. 6).

After the demolition of the boiler building, its underground structures were buried, and a one-floor building without a cellar was built on the north side. This situation remained until the modernisation.

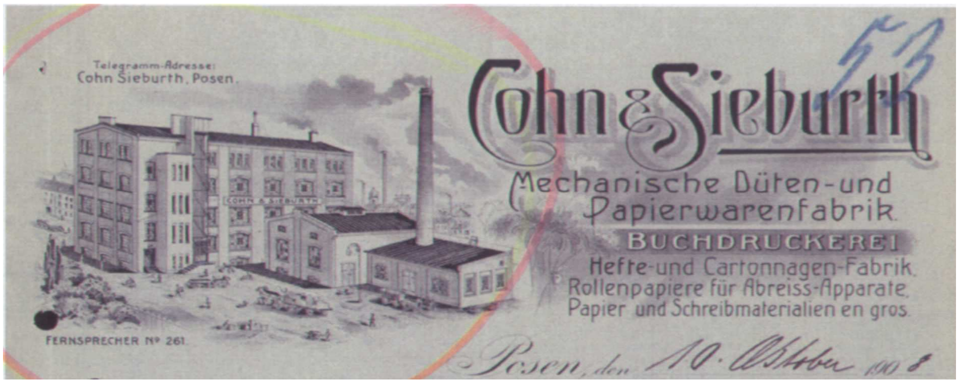

Fig. 3. A view of the dressing room – bath on the company's letterhead, 1908 r.

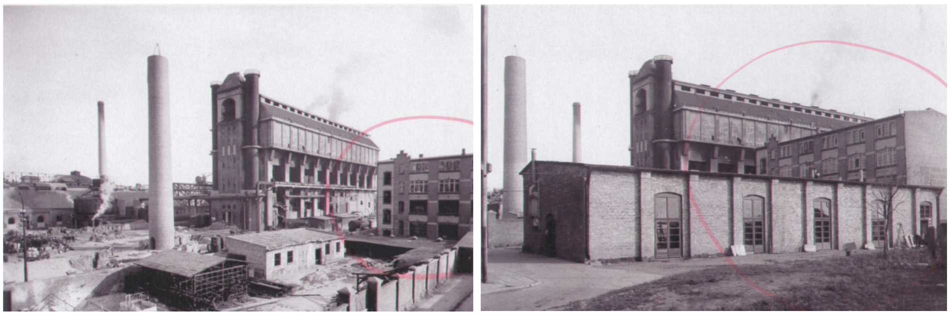

Fig. 4, 5. Koppers' boiler room building, view of 1916 during the construction of the chimney in the 50's

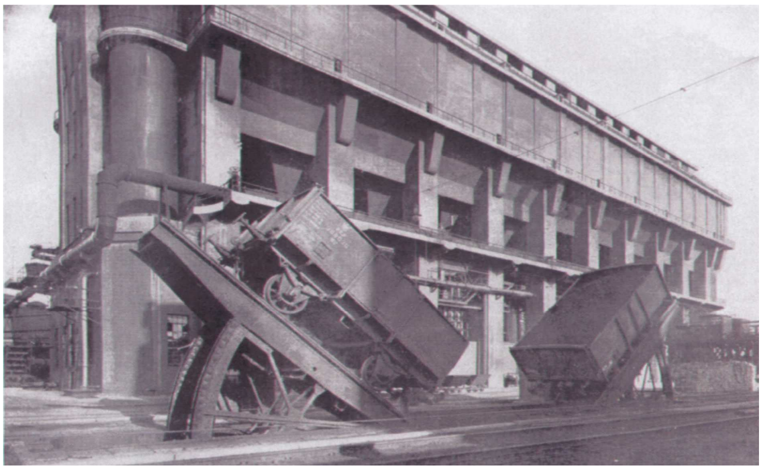

Fig. 6. Wagon discharger, view at the south wall of the the Koppers' boiler room building

3. THE TECHNICAL CONDITION OF THE MODERNISED BUILDING

On the basis of the macroscopic and nondestructive research, the masonry walls were examined. It was found that the walls were built with brick of class 10.0 MPa and lower, on cement-lime mortar of 3.5 MPa (and lower). All the exterior walls were covered with front-face bricks. The walls inside the building were plastered with cement-lime plaster 2-3 cm thick. Floors on all levels were made as ceramic-steel composite ones (fig. 7).

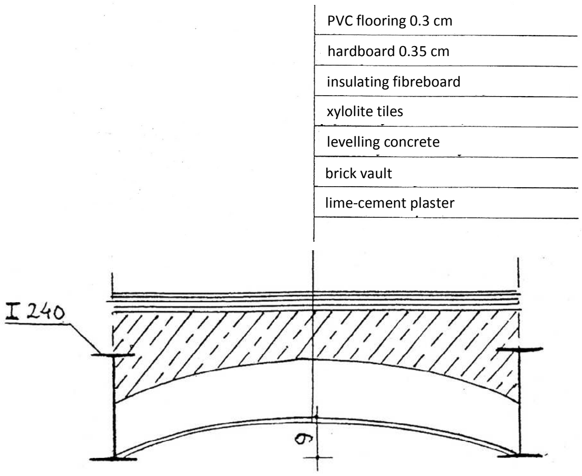

Fig. 7. A cross-section through the existing floor

Floors consist of brick vaults on beams made of I240 steel. The average beam spacing is 0.94 m. The ceramic arch was 12 cm thick, and their bending arrow amounted from 9 to 10 cm. The steel beams are supported on external longitudinal walls of the building and on a steel suspension placed at half-width. The span of the floors is about 9.68 m measured from wall to wall. Beams in both spans are assumed as freely supported. The central joist is produced with two I360. It is supported on indirect columns spaced 4.70m, and rests on the gable walls of the building. The cross section of the steel column is of a circular pipe shape, and consists of four identical profiles connected with rivets (fig. 8). The geometrical characteristics of the sections are taken from [10]. According to the tables presented in the book, profile No. 5 was used on the second floor, profile No. 7 ½ was used on the first floor, and on the ground floor and in the cellar – profile 12 ½. Brick arched and steel lintels were used and produced on the basis of 2 I200, with approximately 15 cm spacing. The wooden gable roof of the building was covered with roofing felt on roof sheating. A longitudinal structure was applied in the building, i.e. the floors were supported on load bearing exterior walls and also on the internal column-beam system.

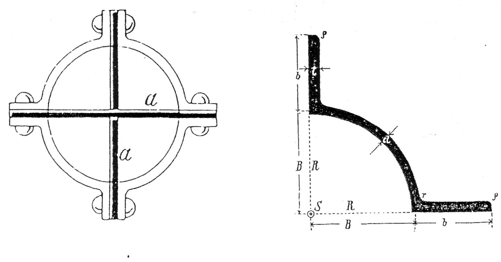

Fig. 8. A cross section of the column supporting the main joist

In order to evaluate the ground-water conditions in the zone of the analysed building, all necessary geotechnical tests were carried out. On the basis of the site- and laboratory tests as well as the necessary analyses, a geotechnical cross-section elaborated (fig. 9).

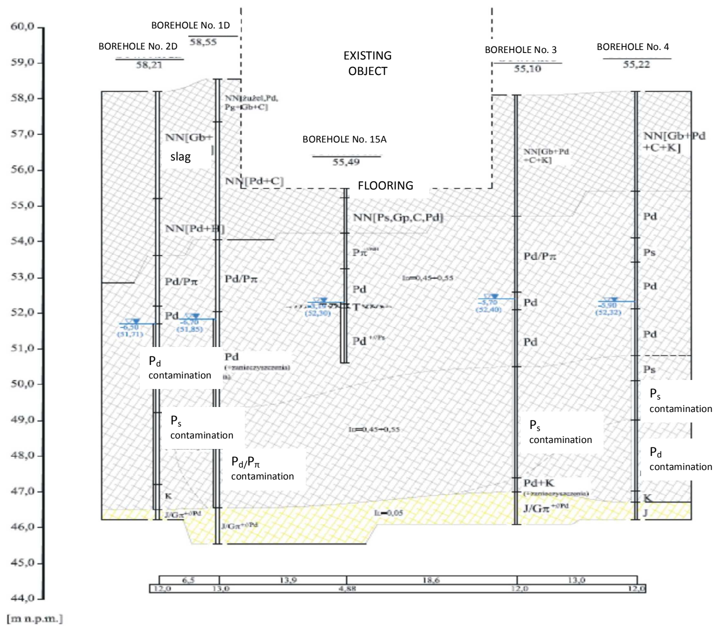

Fig. 9. Geotechnical cross-section under the existing Dressing Room and Bath (Szatnia-Łaźnia)

The analysis (fig. 9) allows statement that the geological structure in the area of Szatnia-Łaźnia (dressing room-bath) building is simple. Under a layer of embankments useless for construction purposes, which are 5.0 m thick, there is a layer of alluvial sands (fine and medium sands with a layer of stones at the bottom). Below ordinate 46 ÷ 47 m above mean sea level, there is a continuous layer of Poznań Formation loams. Due to this, the geotechnical parameters should be evaluated as complex for the occurrence of a layer of embankments of various degree of compaction, from loose to compacted (i_d = 0,35 ÷ 0,60). Within the area of embankments, at the depth of 4 m below the ground level, there are large chunks of rubble and concrete, which posed a substantial hindrances during the geotechnical site tests. Additionally, former coal stores with deep technological rooms, which are the remaining of the former wagon discharger, were found in this area (fig.6). Also, the area was found to be polluted with specific substances (organoleptic test indicated the presence of oil and phenol) at the depth of 6,5 to 12,0 m. It was also found the maximum level of underground water reaches the building foundations, whereas its minimum level is about two meters lower. Additionally, it was found that the ground water did not reveal any leaching, acid, carbonate, magnesium or sulphate aggression to concrete, but it revealed medium ammonium aggression.

The biggest problem of the underground part of the building were the substantial craks and humidity of the interior walls of the cellar in the extension (isolated shelter rooms), which additionally did not have foundations. Unfortunately, also the other walls at the cellar level as well as some of the ground floor walls were strongly humid, too. Another important issue were the craks on the exterior wall of the gable staircase on the northern side. The morphology of the craks indicated clearly that the area under the foundations was overloaded. Additionally, damages to the exterior walls, from the World War II, were found.

4. MODERNISATION AND RENOVATION PROJECT

In the original project, the following works were planned to be carried out in the existing Dressing Room and Bath building (building C): cleaning and renovation of the brick facade according to the guidelines of the building conservation officer; the replacement of window hardware (the window divisions to be maintained in the external glazing), uncovering and exhibiting the internal steel structure (I-beams and riveted steel columns), and exhibiting partially uncovered brick vaults. Unfortunately, no reliable technical expertise of the existing building Dressing Room – Bath was performed and similarly no serious computational analysis was carried out. Additionally, due to the lack of foundation exposals it was impossible to evaluate the technical condition of the foundations.

In addition, an extension was planned to be built, which was to supposed to consists of two parts: a northern part (Building B) and a southern part (Building A). The northern part was planned to maintain the vertical divisions of the elevation. Fields between the pilasters were to be filled with large glazings referring to the existing building. This part was to be crowned with a bay window with panoramic views of the valley of the River Warta and Ostrów Tumski. The southern part was glazed and based on the circle, referring with its shape to the gas tanks. Building A is a spatial keystone and a dominant in the scale of a quarter (fig. 10, 11). This part houses two conference rooms and a foyer of a large hall on the last floor. The rooms are connected by fan stairs and ramps that run along the outer side of the glass shell (fig. 12). The traffic areas are dedicated to exhibit gas technologies.

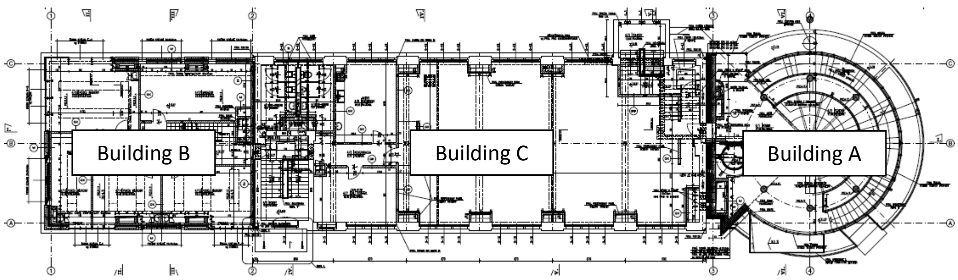

Fig. 10. A layout of the modernized facility together with the northern and southern parts

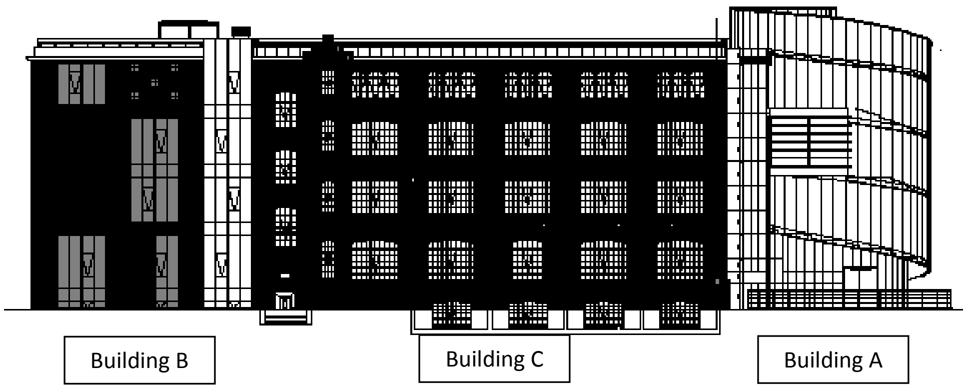

Fig. 11. View of the modernized facility together with the northern and southern parts

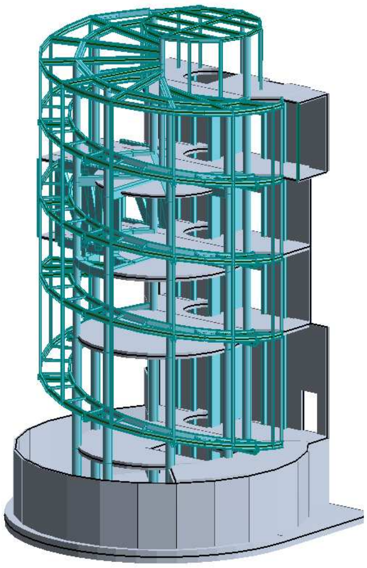

Fig. 12. A model of the structural system of Building A

5. RENOVATION AND MODERNISATION WORKS

Because a reliable technical expertise failed to be performed as well as additional analysis of the foundations of the existing building failed to be carried out, neither the possibility of overloading the subsoil under the foundations in the existing building (Building C) was taken into account, nor it was considered to perform secondary waterproofing in the building or to repair the cracked exterior gable walls (which occurred as a result of overloading of subsoil under the foundations) of the existing building, both in the walls and lintels. The mentioned above works were commissioned by the Investor on his expense. The performed works involved: application of indirect foundations for the new parts of the building, application of a suitable hydro-insulation system in the existing building and in the newly-built parts, repairs of external walls in the existing building, as well as other works such as new solutions for lintels in the passages connecting the existing building with the newly built parts, strengthening of the degraded (due to the designer's errors) existing historic floors and reconstruction of the back side of the staircase.

5.1. Changing the foundations of the new parts of the facility

The carried out analysis of the load bearing capacity of the soil under the foundations of Dressing Room -Bath building, the exterior walls including, showed that it is fully or almost fully exploited. Thus, it was not possible to build the newly designed parts of the building directly on the existing foundations, according to the performed technical design, without causing substantial damages to the existing building of the dressing room – bath. Because of the above, it was necessary to design the way in which loads exerted on the subsoil by the newly designed parts would be transmitted into its deeper layers, to prevent the cumulation of the values of stresses resulting from loads exerted by the existing building (Dressing room – Bath) and the newly designed parts from exceeding the load bearing capacity of the given subsoil layer. In order to ensure it, an indirect foundation was applied to the newly designed parts of the building which would base on jet grouted columns (Solicrete T), as the safest and the most efficient solution (fig. 13).

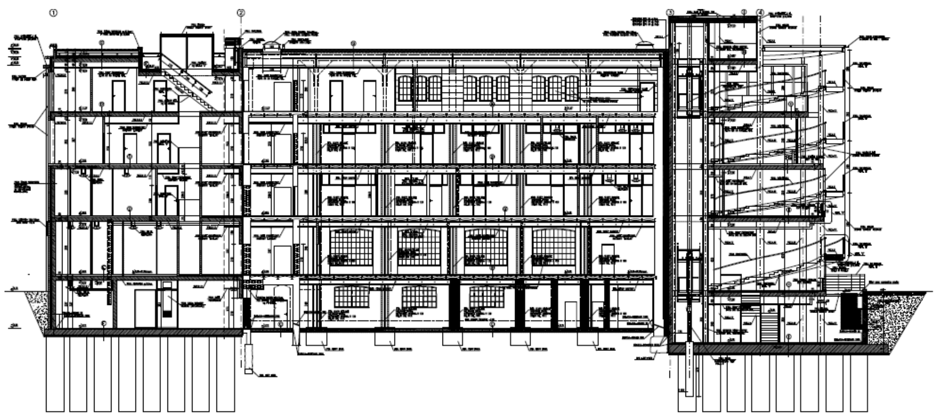

Fig. 13. Distribution of jet grouting piles under part A and B (cross section)

Due to the fact that the subsoil was polluted with oil and phenols at the depths ranging from 6.5m to 12.0 m, it was necessary to consider this fact while producing the *Solicrete* columns, which was realised by assuming the piles to be made of cement CEM I and by using three-stage technology to stiffen the contaminated subsoil.

5.2. Waterproofing

In order to produce tight waterproofing barriers in the existing building, a technology applying horizontal injection siloxane was used and a system of internal and partly external polymer-cement coatings, which simultaneously produced a load bearing layer of the floor on the existing embankments. Before producing the internal coatings, the walls were injected and after the coatings were produced the walls were plastered with an intelligent renovation plaster. Outside, above the ground level, the walls were additionally hydrophobizated (fig. 14).

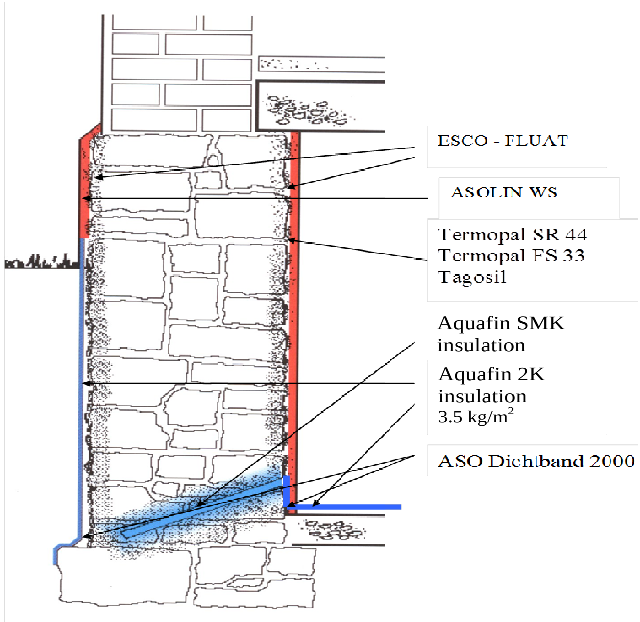

Fig. 14. Schematic waterproofing system in the existing part

In the new parts, a system of polymer-cement coatings was produced, and carefully connected with the new waterproofing system of the existing building.

5.3. Exterior walls repairs

Bearing in mind the historic value of the building elevations, the repairs of the craks on the exterior structural walls were performed basing in the innovatory repairing system PCC connected to system HELIFIX. Connectors, anchors and reinforcing rods, which form the basis of the solutions, are produced from austenitic stainless steel using a unique spiral design Hi-Fin (fig. 15).

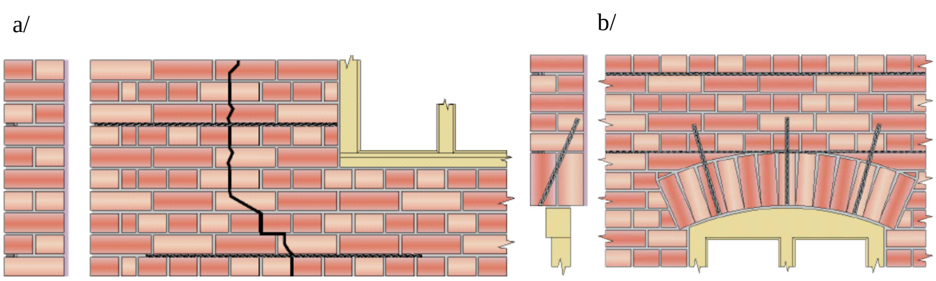

Fig. 15. Repair system applied to the exterior walls
a / walls themselves, b / lintels

5.4. Other works

The biggest misconception was the newly designed lintels between buildings A and C, as well as B and C. The first version of the project included lintels based on a system of I-section, which was totally impossible to produce and could only lead to to destruction or failure of historic building C. On the request of the investor's supervision, lintels were redesigned into a system of two C-sections tightened with screws, thus leading to the formation of composite steel-ceramic lintels. However, the designer planed a monstrous solution based mainly on [240 tightened with bolts M30, class 8.8 (lintels between Buildings B and C). The situation was not much better in the case of lintels between Buildings A and C. Additionally, the designer planned that the screws were to be prestressed with a prestressing moment 2,2 kNm, i.e. generating almost twice the tensile force than the load bearing capacity of adopted screws. During the realization works, a failure occurred yet with the use of a much smaller prestressing moment. A wall between C-sections was crushed, and the web of the C-sections was weakened. Within the investor's supervision they were redesigned and produced correctly.

Due to the poor technical condition and safety risks of the back staircase (fig. 2), it had to be dismantled and reconstructed conforming to all the requirements of the building conservation officer (fig. 16, 17).


Fig. 16, 17. Restoration of the back staircase basing on SCC concrete

In order to connect it rigidly to the main building, self compacting concrete was used (for the first time in Poznań, or even maybe in Poland). It was impossible to use a classical kind of concrete due to the poor technical condition of the existing building and the fact that various kinds of steel merged with each other (fig. 16, 17). Self compacting concrete provides tight filling of the boarding yet under its own weight, while maintaining high uniformity even if there is a dense reinforcement [11]. It is a unique product especially useful when vibrators cannot be applied, also in the case of erecting additions or expansion of existing facilities, particularly historic ones, and also when formed and reinforced steel merge with each other. On the basis of the formed superstructure, a three-layer wall was produced with an elevation layer made of specially selected face bricks.

6. SUMMARY

Improper decisions of the designer team, inexperienced in renovation and modernisation projects, may result in damage or even destruction of renovated historic facilities. It may also lead to excessive expenses for the Investor. An example of such a situation has been presented above. Only through effective services of the Investor's supervision, the Investor's good will and their financial capacity, it was possible to carry the successful renovation of the modernization process of one of the most interesting post-industrial objects in Poznan in the Old Gasworks. Despite this, the realised investment received two national awards: „Modernizacja 2011" under the auspices of the Ministry of Infrastructure and a honourable mention in the competition: „Zabytek Zadbany 2012" in the category "Industrial Architecture and Technical Heritage" under the auspices of the National Building Conservation Officer.

BIBLIOGRAPHY

1. Affelt W.: *Rewitalizacja w kontekście zrównoważonego rozwoju*, Workshop on Advanced Mechanics of Urban Structures, 24-25.09.2003, Gdańsk.
2. Affelt W.: *Dziedzictwo w budownictwie albo o obiektach budowlanych jako dobrach kultury ksiąg dziesięć*, Gdańsk, WPG, 1999.
3. Błaszczyński T., Rosolski S.: *Adaptation of an old gasholder for Service-Office Center of the Kalisz Power Plant in Ostrów Wielkopolski, Poland*, 16th Congress of IABSE, Structural Engineering for Meeting Urban Transportation Challenges, Lucerne, 2000, 334-342.

4. Błaszczyński T.: *Rewitalizacja historycznych budynków przemysłowych w kontekście zrównoważonego rozwoju na przykładzie adaptacji XIX w. zbiornika po gazie na obiekt usługowo-biurowy*, Biuletyn WOIIB, 6 (2005) 20-23.
5. Błaszczyński T., Wdowicki J., Wdowicka E.: *Rewitalizacja budynku biurowego,* Workshop on Advanced Mechanics of Urban Structures, 24-25.09.2003, Gdańsk, 109-112.
6. Błaszczyński T.: *Adaptacja obiektu zabytkowego na Browar z Hotelem w Poznaniu*, Renowacja budynków i modernizacja obszarów zabudowanych, Tom 4, Zielona Góra 2008, 55-64.
7. Błaszczyński T.: *Modernizacja XIXw. komina przemysłowego*, Przegląd Budowlany, 11 (2012) 43-46.
8. Błaszczyński T., Zgoła B., Kukurenda K., Bazela Cz.: *Trwałość i skuteczność napraw w ponad stuletnim obiekcie budowlanym* w: Trwałość i skuteczność napraw obiektów budowlanych, ed. M. Kamiński, J. Jasiczak, W. Buczkowski, T. Błaszczyński, Wrocław, DWE, 2007.
9. Błaszczyński T.: *Trwałość rewitalizacji historycznego budynku przemysłowego w kontekście zrównoważonego rozwoju*, Przegląd Budowlany, 4 (2011) 40-47.
10. Breymann G. A.: *Allgemeine Baukonstruktionslehre*, tom III, Die Konstruktionen in Eisen, Leipzig 1902.
11. Burzyńska K.: *Beton w budownictwie zrównoważonym*. „Builder”, 11 (2008) 43-46.

RENOWACJA Z MODERNIZACJĄ BUDYNKU POINDUSTRIANLEGO W POZNANIU

S t r e s z c z e n i e

W pracy przedstawiono renowację zabytkowego budynku poindustrialnego znajdującego się na terenie Poznańskiej Gazowni. Nieprzygotowany zespół projektowy popełnił wiele błędów i zaniechań, co doprowadziło do dodatkowych prac, w tym naprawczych. Zwiększony zakres prac doprowadził również do znacznego zwiększenia kosztów realizacji przeprowadzanej renowacji. W trakcie realizacji prac zastosowano wiele nowoczesnych technologii, niektóre po raz pierwszy na terenie Poznania.