

TASKS AND PROBLEMS IN THE BUILDINGS DEMOLITION WORKS: A CASE STUDY

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In Poland, it often happens that construction objects are subject to demolition work for different reasons. Demolition, according to the Construction Law, is defined as a type of construction works and, as such, represents a particular type of construction project. As in other construction projects, a very important phase, in addition to execution of the works, is to prepare, design and plan demolition works. Some demolition activities are covered by appropriate regulations and can be described as typical. On the other hand the technical side of demolition works depends on many factors such as: the type of building, its age, technical condition, type of construction, etc. This article covers the analysis of the stages and tasks in the preparatory phase of the building demolition. This work will also present a description of the tasks carried out during the demolition works based on the example of a historic tenement house located in Krakow. This analysis aims to identify implementation problems and sources of risk that may occur during this type of construction work.

Keywords: demolition works, the risk, construction project, legal regulations

1. INTRODUCTION

Demolition works are an integral part of the construction works. Each designed object has a fixed life span, and the last stage of its life cycle is coming out of use. In recent years, an increasing number of the demolition of buildings that have been carried out can be observed in Cracow. The city is full of historical buildings whose technical condition requires major repairs or demolition. One of those objects which was liquidated was the chemical dye house building (laundry)

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"Rainbow" located inside AGH Campus at the Czarnowiejska Street, whose demolition was watched by the authors. This was an example of a good "job".

Demolition works as construction works (Construction Law) are a specific type of construction project in which particularly in the execution phase, many difficult technical situations occur, uncertainties, which constitute a source of risk. For those reasons and also because of the specific legal requirements - especially concerning historical buildings, the work associated with the preparation of demolition works require a lot due diligence and knowledge of the rules, as well as proper design and planning of demolition.

The subject of this article is the analysis of the stages and tasks in the preparatory phase of a building's demolition. The paper will also present a description of the tasks carried out during the demolition of the building based on the example of a historic building located in Krakow. This analysis aims to identify implementation problems and sources of risks that may occur during demolition work.

2. PREPARATION PHASE OF THE BUILDING'S DEMOLITION PROJECT

Demolitions of buildings are made for many reasons, e.g. bad technical condition of the building resulting from unauthorized construction [2], elimination of industrial facilities, etc... Demolition projects, like the other type of works, are subject to legislation. Depending on the reason for which the decision on demolition was made, they are subject to varied requirements in terms of the laws that regulate the construction activity. For example, in the case of building structures destined for liquidation with the usage of explosive materials as well as in the case of demolition resulting from the damage caused by the environment, there are additional, separate regulations. Additional, separate rules apply to historical facilities. Stages of the proceedings in the preparatory phase to obtain a demolition permit are similar to the general scheme, but it should be pointed out that the additional participant in administrative proceedings is the Municipal or Provincial Conservator of Monuments. His consent is required in order a permit for demolition.

The practice indicates that the preparatory phase of the investment project, which is the liquidation of the object, as it is in the case of erection of new buildings, is usually longer than the other phases of the project. Steps involved in this phase and tasks that should be performed before accession to demolition works were categorized and presented in the form of a block diagram shown in Fig. 1. Grey colour marks the steps which involved the demolition of the described object.

Depending on the construction project of the "demolition of a building" type, the preparatory process includes various activities that typically take a long time and this period is extended by the statutory

waiting periods for decisions. In the case where, as a result of poor technical condition of the object, it comes to threat of life or property, the demolition work with a simultaneous complement of administrative affairs can be and even should be immediately commenced. However, these regulations shall not be applied to the objects included in the register of monuments. In the case of the described demolition, the permission for demolition was necessary due to the bad condition of the property and its historical character [2].

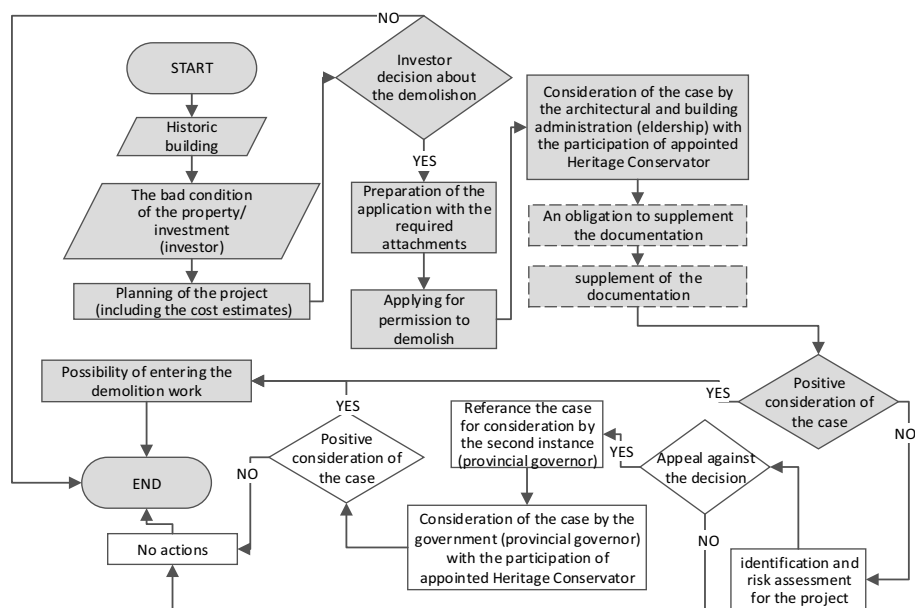


Fig. 1. Step chart preceding the start of demolition historical building (indicated by the dashed line situations that may occur). Source: own study based on [2] i [3]

The Request for granting consent to demolish was submitted to the office on 25.07.2012. Because of the historical value of the object, the Rainbow building required consent for demolition, granted by Municipal Heritage Conservator acting in agreement with the Provincial Conservator, to whom the case was brought to on 21.08.2012. Because of the additional requirements of conservation, the Investor was obliged to submit additional documents - the decision was issued on - 01.10.2012. The application was completed by the Investor, and with the date of 01.04.2013, after receiving the

consent of the conservator, the City issued a demolition permit [1]. It took the investor a long period of time to prepare and conduct the tender for the demolition works of the "Rainbow" object.

The preparation phase from the submission of the application to the contract awarded to the entrepreneur lasted 21 months. The execution of the demolition, including the development of the technical design, fencing and site preparation for parking - less than 3 months (Fig. 2).

After the contract was awarded to the entrepreneur, there was the preparatory phase preceding the demolition work started. In this phase there was the project of the execution of the works developed, including demolition work methods, their order, applied devices dependent on the technical condition of the object, and other conditions for the implementation of the demolition (location of the property, site etc.).

This project also included the Safety and Health Protection plan. It should be noted that the protection of life and health of workers is a key element of the demolition, as the risk of an accident in this type of works is one of the highest among all building operations [5].

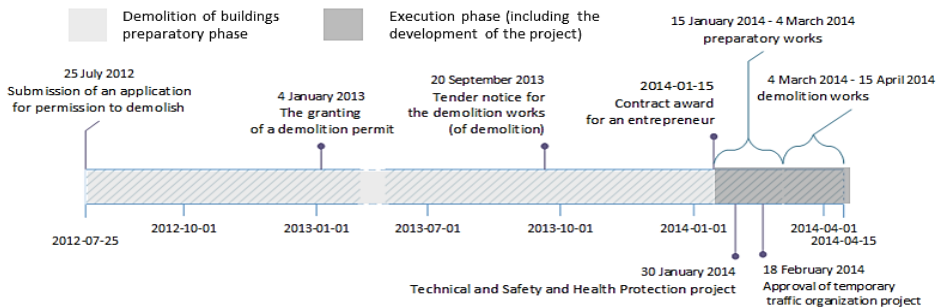


Fig. 2. The course of the investment process of demolition "Rainbow" in Cracow, Source: own work

The beginning of the demolition works is also often preceded by obtaining permits for the exclusion of the pavement lanes, heavy equipment transport, disconnection of the media, etc. The construction market saw the emergence of companies specializing in the execution of building demolition projects in a comprehensive way from the moment of the order. They work in a high risk environment, requiring extensive knowledge, experience and thorough preparation for construction work. The next chapter presents a worth-following example of the implementation by a specialized enterprise.

3. PHASE EXECUTION OF DEMOLITION OF THE BUILDING - AN EXAMPLE

3.1. HISTORY AND TECHNICAL CONDITION OF THE LIQUIDATED OBJECT

The "Rainbow" object was formerly a building of dry cleaning service on Czarnowiejska Street. The Tenement was erected in the second decade of the twentieth century and was the property of a citizen of Cracow, Alexander Mandelbaum. In 1920, the tenement was expanded. The industrial-residential building was enlarged by an additional floor, and an extra complex of buildings was built on the yard side, i.e. a hall laundry, dyeing, benzindose, boiler and chimney factory [13].

The complex of buildings on the Czarnowiejska Street represented a modern industrial architecture of Cracow of that time. In the time span of its existence (life cycle), due to the changes in its functions, it was rebuilt several times. In the years from 1955 to 1990 it was used, among others, by the Regional Criminal Management Board as an outhouse and warehouse complex [13].

Since the early nineties, the technical condition of the building had been deteriorating each year, which contributed to the lack of interest in the property on the owner's part which resulted in the building falling into disrepair (Fig. 3 and 4). Finally, after several years the AGH University Authorities managed to redeem the property.



Fig. 3. The top view of the complex of the dry cleaning service "Rainbow" before the demolition, after the fire, around 2012, Source: googlemaps, 06.03.2014]



Fig. 4. The view from the Czarnowiejska street on the right wing of the laundry service building "Rainbow", Source: own photo, 06.03.2014

In the winter of 2011 a fire broke out in the tenement, it was caused by homeless people living there. The fire damaged the building heavily, the roof collapsed, and destroyed the second floor of the building (Fig. 3). During this time the demolition works of individual elements of the laundry-service

complex had been already conducted by the Investor (AGH University). In June 2013, only the front building remained, visible directly from the Czarnowiejska Street (Fig. 4).

The external walls of the laundry service with a thickness of 45 cm were made of solid brick, combined with lime mortar, anvil-laid thread. Internal walls consisted mostly of wooden boards covered by clay on reed, which was directly applied to the plaster. The floors were made of wooden beam construction or reinforced concrete. Land property was armed in the following networks: water supply, sanitary sewer, storm water and energy network, as well as a central heating network.

3.2. THE DEMOLITION WORKS

The demolition of a three-storey building located in the frontage of the Czarnowiejska Street and one-storey outhouses from the courtyard started on 04.03.2014. After receiving the permission for demolition, the investor was obliged to notify the competent supervisory authority about the intended date of commencement of works. The notification had to include:

- manager's declaration confirming the draw-up of the safety and health plan,
- the acceptance of the duty to manage the construction.

The Contractor specializing in demolition, who has been commissioned to carry out the demolition, began the works from the development of the technical design. However, The Assessment of the technical condition was hampered because of the fire of the wooden construction of the roof in 2011. The fire completely destroyed a part of the roof trusses and ceiling on the first floor. Because of that, the interior of the damaged building was subjected to the weather conditions for several years.

After the visual inspection of the tenement, it was found that there is a threat of collapsing. In addition to the direct cause of the degradation of the object that was made by the fire, it was also observed that in the front elevation and lintels there are large defects of material and numerous cracks. Due to the close proximity to other buildings, the parcel had to be carefully checked and all networks disconnected and secured before the demolition.

The Schedule for the completion of the works is presented in Table 1.

Table 1. The schedule of the general demolition of the building "Rainbow" on the basis of [8]

Stages of demolition of building	Data
Taking over the site by the demolition company	15.01.2014
Submission of appropriate proposals for demolition works (e.g. permit to exclude sidewalk for the duration of the works, permit to transport heavy equipment, permit to disconnect the media, etc.).	30.01.2014 – 18.02.2014
The construction site area development plan, among others: isolation of the construction site, permanent disconnection of the outdoor-installation powering the facility, marking roads of their run near the active power and water installations, designation of a security zone, preparation of directions and stations for the work of heavy equipment, the designation of a temporary storage place for debris, scrap metal and other materials from the demolition, isolation of the danger zone from the Czarnowiejska Street.	28.02.2014 – 04.03.2014
Demolition works, including: demolition of the outbuildings from the yard, mechanical demolition of the upper floor to the ground level, the demolition of brick walls on the ground floor and the first floor, the demolition of the foundation walls, insulation of heavy foundations and basement foundation walls of the building B7, curing the area, construction leveling layers on the walls of buildings adjacent to the object [Fig.5]	04.03.2014 – 15.04.2014
Segregation of the demolition materials, among others: preliminary debris crushing with steel reinforcement separation, segregation of the demolition materials with cutting into sections to transport, export of the waste materials [Fig. 6]	10.03.2014 – 01.04.2014
Ordinal and finishing works, among others: trimming and leveling the site, hardening the area, (the) execution of the facade on the buildings adjacent to the tenement under the demolition	01.04.2014 – 15.04.2015



Fig.5. The laundry building "Rainbow" demolition, Source: own photo, 03.2014



Fig. 6. The segregation of materials from the demolition of the building, Source: own photo, 03 - 04.2014

The demolition works were entirely mechanized. During the works at the construction site, there was a working group consisting of two operators of heavy equipment, foreman and three unqualified workers, who successively led the segregation of waste and the material loading.

In the Table 2, there is the sequence of demolition works presented [8, 7].

Table 2. The order of the execution of the demolition works of the "Rainbow" [8]

1	Demolition of the outbuildings on the yard side
2	Removing the roof structure damaged in the fire
3	Successive demolition of curtain walls (from the upper floors by cutting, breaking, crushing small fragments of structural elements of a building by crushing with scissors or breaking with hydraulic hammer)
4	Cutting each slab of the building, starting from the top floor
5	Demolition of brick walls on floors and ground floor level consecutively
6	Demolition of the foundation walls to the level of -0.50 m below; from the side of the building B7 AGH, the demolition to a depth of 2.8 m.
7	Insulation of heavy foundations and basement foundation walls of the building B7
8	Asphalt demolition from the square behind the building
9	The collection of the top layer of soil to a depth of approx. 20 cm in purpose of hardening
10	Hardening site by the broken aggregate (key aggregate)
11	Execution of leveling layers on the walls of buildings adjacent to the demolition object
12	To-date pre-crushing of rubble with separation of steel reinforcement
13	Segregation of demolition materials with cutting into transport pieces
14	Export of waste materials
15	Trimming and leveling the area

4. THE REALIZATION PROBLEMS WITH THE BUILDING DEMOLITION

The realization of the demolition of the "Rainbow" building, which is a historic building, located in a densely built-up area, in a very bad technical condition caused a lot of problems, both in the preparation phase of the project as well as in the execution phase. Preliminary issues are:

- problems during the redemption of property from the owner who lives outside Poland,
- additional documents required during the application process for the permission for demolition,
- additional permission required for the demolition from the Municipal and Provincial Conservator of Monuments,
- difficulties in assessing the technical condition of the object because of the disastrous state of the building affected by the fire (the completely destroyed roof and ceiling of the second floor),
- heavy machinery transport to the construction site was hampered because of the location of the "Rainbow" building and could be made only at night,

- location of the building required the closing of the sidewalk from the side of the densely frequented Czarnowiejska Street. Closing the pedestrian corridor required the permission for the entire duration of the demolition.

During the execution of the demolition, the contractor also encountered difficulties with:

- the demolition of the building's front wall was connected with designation of the security zone (6 m plus 1/10 of the height of the object) whose extent made it necessary to close the whole Czarnowiejska Street. The Demolition of the front wall of the building had to be completed within a few hours, which was the time approved for the closure of the strip of the street. Due to the heavy traffic that which is typical for this location, the works were planned for one of the Sunday mornings; it is worth noting that the exclusion of traffic on the Czarnowiejska Street, even for a few hours, caused very high costs (several thousand zlotys),
- in the structure of the building, there were dangerous materials requiring selective collection during their removal. These side effects included the residues of papa roofing and glass wool insulation that were part of the building. Due to the provisions, the specified materials were collected in separate containers and turned over to the points for disposing,
- the direct vicinity of the busy street and surrounding buildings required the protection of the area against excessive dusting and dust that accompanied the process of demolition. The leveling of those disadvantages required the irrigation of the building elements, both in the course of the demolition and loading materials onto the transport means,
- the phase of the demolition of the building's gable wall required a change in work technology. Because of the danger of an uncontrolled collapse of the wall, works had to be done manually,
- the final stage of the demolition of the terrestrial part also had to be done manually because of the direct proximity of other objects.

Currently, in the areas of the former laundry complex, there is a car park for employees of the University. In the near future, another investment is planned there, which is now in the design phase. The demolition works are considered as high-risk construction works and are characterized by a range of very hazardous working conditions.

Because of their difficult nature they should be planned and controlled in accordance with the legal requirements. The hazards associated with the demolition works include:

- the instability of the demolished object structure,
- excessive loading on floors and loading against walls,
- unprotected openings,
- the presence of harmful materials, i.e. asbestos and broken or sharp pieces of glass, metal, etc.,

- adverse weather conditions,
- obstructed site access,
- the discontinuation of services such as electricity,
- the use of hazardous materials, i.e. explosive materials [4].

The demolition of the "Rainbow" was carried out efficiently and in accordance with the scheduled time, what can be attributed to the works manager's big experience in this kind of work. The presented example shows that the preparatory phase of demolition is the most time consuming part of the project and requires the investor knowledge and perseverance in obtaining the necessary permits for its completion. It also requires skills of risk management both in the preparatory and executive phases. Below the authors have presented a summary of the risks that arise in this type of projects [Table 3].

Table 3. Summary of risk during the planning and execution of the demolition [4, 5, 9, 10]

No.	TYPE OF RISK	RESPONSIBILITY	
		Investor	Contractor
1.	Problems with the ownership of the land / real estate	✓	
2.	Obtaining the proper permits to carry out the construction work	✓	
3.	Demolition of a building under conservation protection	✓	
4.	Difficulties in assessing the technical state of constructions	✓	✓
5.	Transport of heavy equipment to the construction site		✓
6.	Changing the technology works during the project		✓
7.	Necessity of execution of works comply with the deadline imposed by the Investor		✓

In addition to the risk factors associated with the entire project, risk factors for humans occurring in demolition works should also be noted. These include: disruptive noise and dust, unfavorable weather conditions, electrocution while operating machinery, equipment and tools powered electrically, cuts, burns, fractures, injuries caused by falling objects or debris, falls from height, injuries resulting from the use of explosives materials, diseases associated with the removal of dangerous materials, ie. Asbestos.

Implementation by the participants of the project risk management concept aims to minimize the effects of possible risk through the investment methods (avoidance, transfer, acceptance of risk, etc.) [11].

While the measures that reduce the risk to humans and improve the safety conditions on the site include:

1. Risk identification (the scale, the type of risk and the time and place of their occurrence)

2. Risk assessment of the possible danger
3. Health and Safety training and instruction workers before the commencement of extremely dangerous works
4. Preventive care during demolition work (eg. social facilities properly equipped)
5. Determining the procedure in the case of a risk occurrence
6. Provision of personal protective equipment by employees
7. Marking locations for carrying out the construction works, determine ways to store and transport dangerous materials at the construction site
8. Providing technical measures (including the masks, clothes etc. for particularly dangerous works) and the work organization plan, to minimize the risk of danger at the site
9. Providing the means for effective communication and, if necessary, to enable quick and efficient evacuation

These activities are elements of the Safety and Health Protection plan, which are required to be prepared by on site managers and others such as demolition of buildings with a height of over 8 m.

5. CONCLUSIONS

The implementation of demolition of the former laundry complex "Rainbow" confirms that projects consisting of decommissioning of a building, especially historical, are the same as construction of new investments. These are complex activities requiring extensive knowledge and experience from their executors, ie both investors and contractors [8]. In addition, each object of demolition is an individual process - unusual. During their realization, there are multiple extra uncertainty factors and risks in particular due to inaccurate stocktaking and insufficient knowledge of the technical condition of the objects. In the preparatory phase, there are additional problems associated with obtaining a permit to start construction works and in the execution phase there are technical and work related safety problems.

As it is apparent from the analyzed example, the demolition investment process is essentially formalized and extended especially in the preparatory phase, which has a negative impact on its length. Current changes in the Construction Law (Law from 20 February 2015) introduce the simplification and shortening of the procedures necessary to implement the construction project in many cases [6, 11, 12] These trends are promising for the construction sector; legislative changes carried out in this direction bring a lot of good for the investors. The completed modernizations can positively influence the dynamism of the construction market, encouraging investment in this sector.

To avoid the difficulties in the demolition implementation, the possible sources of risk and the probability of their occurrence should be carefully analyzed and the use of risk management tools should be implemented.

The implementation of the building demolition presented in the article was carried out efficiently and in accordance with scheduled time and planned costs, and represents "an example worthy of imitation" thanks to proper preparation and experience of the contractor.

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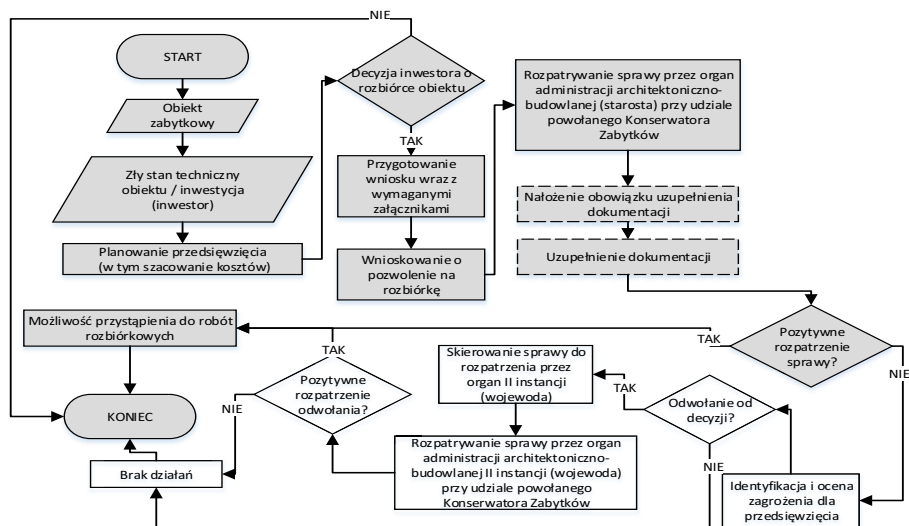
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ZADANIA I PROBLEMY W ROZBIÓRKACH BUDYNKÓW: STUDIUM PRZYPADKU

Słowa kluczowe: roboty rozbiórkowe, ryzyko, przedsięwzięcie budowlane, regulacje prawne

STRESZCZENIE:

Coraz częściej w Polsce obiekty budowlane z powodów złego stanu technicznego, funkcjonalnego, ekonomicznego, itp. są likwidowane - rozbierane. Rozbórka w Prawie budowlanym zdefiniowana jest jako typ robót budowlanych i jako taki stanowi szczególny rodzaj przedsięwzięcia budowlanego. Podobnie jak w innych przedsięwzięciach bardzo ważną fazą jest przygotowanie, zaprojektowanie i zaplanowanie robót rozbiórkowych. Niektóre działania w zakresie rozbiórek objęte są właściwymi przepisami i można je określić, jako typowe. Natomiast techniczna strona robót rozbiórkowych zależy od wielu czynników takich jak: rodzaj budynku, konstrukcji, wiek, stan techniczny, funkcjonalny, technologia wykonania, lokalizacja itd. Artykuł obejmuje analizę etapów i zadań w fazie przygotowawczej rozbiórki obiektu budowlanego. Natomiast problemy natury technicznej robót rozbiórkowych przedstawiono na przykładzie zabytkowej kamienicy znajdującej się na terenie Krakowa. Analiza procesu przygotowania i wykonania rozbiórki obiektu ma na celu wskazanie problemów realizacyjnych oraz źródeł ryzyka, jakie mogą wystąpić podczas tego rodzaju prac budowlanych. Praktyka wskazuje, że faza przygotowawcza przedsięwzięcia, jakim jest likwidacja obiektu, tak jak przy nowo budowanych obiektach, jest zwykle dłuższa niż pozostałe fazy. Etapy składające się na tę fazę i zadania, jakie należy wykonać przed przystąpieniem do robót rozbiórkowych, zostały uporządkowane i przedstawione w postaci schematu blokowego przedstawionego na Rys.1. szarością oznaczono etapy dotyczące rozbiórki analizowanego w artykule obiektu.



Rys.1. Schemat postępowania poprzedzającego rozpoczęcie robót rozbiórkowych obiektu zabytkowego (linią przerywaną zaznaczono sytuacje, które mogą wystąpić). Źródło: opracowanie własne

Roboty rozbiórkowe poszczególnych elementów i ustrojów budowlanych kamienicy prowadzone były według starannie przemyślanej kolejności przez doświadczonego specjalizującego się w rozbiórkach wykonawcę. Świadczy o tym fakt, że obiekt rozebrano w niespełna 3 miesiące, łącznie z opracowaniem projektu technicznego, ogrodzeniem i przygotowaniem terenu pod parking (Rys.2). Natomiast faza przygotowawcza od złożenia wniosku do udzielenia zamówienia wykonawcy trwała 21 miesięcy.



Rys.2. Widok z góry na kompleks pralni chemicznej „Tęcza” przed wyburzeniem, po pożarze, około 2012 [źródło: googlemaps, 06.03.2014] ; Obecnie funkcjonujący parking w miejscu po pralni

Realizacja rozbiórki budynku Tęczy, jako budynku historycznego, zlokalizowanego w gęstej zabudowie i o bardzo złym stanie technicznym nastręczała wiele problemów zarówno w fazie przygotowania przedsięwzięcia jak i w fazie wykonawczej. Problemy wstępne to:

- trudności podczas odkupywania nieruchomości od właściciela z zagranicy,
- zgromadzenie dodatkowych dokumentów do wniosku o pozwolenie na rozbiórkę,
- wymagana dodatkowa zgoda na rozbiórkę od Miejskiego i Wojewódzkiego Konserwatora Zabytków,
- trudności w przeprowadzeniu oceny stanu technicznego obiektu ze względu na bardzo zły stan kamienicy dotkniętej pożarem (całkowicie zniszczony dach i strop drugiego piętra),
- utrudniony transport ciężkiego sprzętu na teren budowy ze względu na lokalizację budynku „Tęczy” przy ruchliwej ulicy - mógł odbywać się tylko w godzinach nocnych,
- usytuowanie kamienicy wymagało zgody na zamknięcie chodnika ulicy dla pieszych.

Natomiast utrudnienia, z którymi musiał zmierzyć się sam wykonawca podczas prac rozbiórkowych to:

- rozbiórka ściany frontowej budynku wiązała się z wyznaczeniem strefy bezpieczeństwa (6 m +1/10 wysokości wyburzanego obiektu), której zasięg wymagał zamknięcia ulicy Czarnowiejskiej. Prace wyburzeniowe ściany frontowej budynku należało wykonać w ciągu kilku godzin, w których uzyskano zgodę na zamknięcie pasa ulicy. Ze względu na duży ruch uliczny jaki odbywa się w tej lokalizacji prace przewidziano na jeden z niedzielnych poranków,
- w wykonaniu konstrukcji budynku znajdowały się materiały niebezpieczne, wymagające selektywnej zbiórki podczas ich demontażu (papa z pozostałości pokrycia dachowego oraz wata szklana - część izolacji budynku. Ze względu na przepisy, materiały te gromadzono w oddzielnych kontenerach i oddawano do punktów zajmujących się ich utylizacją,

- bezpośrednie sąsiedztwo ruchliwej ulicy i zabudowań wymagało zabezpieczenia otoczenia przed nadmiernym pyleniem i kurzem, jakie towarzyszyły wyburzaniu. Niwelacja tych uciążliwości wymagała polewania wodą wyburzanych elementów konstrukcji budynku zarówno podczas prowadzonej rozbiórki jak i załadunku materiałów na środki transportowe,
- ściana szczytowa budynku była rozbierana ręcznie ze względu na niebezpieczeństwo niekontrolowanego zawalenia się, również ręcznie wyburzano przybudówki ze względu na bezpośrednie sąsiedztwo innych obiektów.
- Wszystkie te trudności stanowiły potencjalne źródła ryzyk skutkujących niedotrzymaniem czasu, terminu i jakości realizowanego przedsięwzięcia. Jednakże dzięki dobremu przygotowaniu i doświadczeniu wykonawcy inwestycja została wykonana w planowanych terminie i kosztach, co stanowi „przykład godny naśladowania”.