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CONSERVATION OF 19th CENTURY DEFENSIVE STRUCTURE. THE CASE OF FORT SWOSZOWICE IN CRACOW, POLAND

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Abstract

This paper discusses the issues associated with conservation of selected elements of the existing military object. The subject was presented on the case of Fort Swoszowice, which is the late 19th century defensive structure recently renovated and adapted to new function. Fort Swoszowice belongs to the system of fortifications that were built in concentric rings around the city of Cracow during Austro-Hungarian monarchy. After decades of neglection, the fortifications are getting more attention as important parts of the cultural heritage of the city. One group of problems associated with conservation of the structure addressed the technical condition of the materials: concrete, brick and metal elements, which showed the signs of deterioration due to lack of proper conservation. The other group of problems were connected with military purpose of the building. The descriptive methodology was chosen as the most appropriate for the case study. The archival maps and manuals were studied in order to get knowledge on the conditions specific for the military structure. Furthermore, the conservation and restoration procedures are described, with emphasis on the factors that determine the identity of the building. Finally, the result is presented, which show that conservation based on diagnosis of the existing conditions and recognition of the archival resources can help in restoration in accordance with the original state and adaptation to a new function.

Keywords*: Concrete conservation; Brick preservation; Metalwork; Krakow Fortress; Fortification architecture.*

Introduction

This paper presents some selected issues connected with the restoration of a 19th-century military structure. The problems associated with preservation and restoration of the existing structure were recognised and presented on the example of the Swoszowice Fort located in the southern part of Cracow, Poland.

The results show that restoration based on a diagnosis of existing conditions and careful recognition of archival resources can help in the recreation of the original state and adaptation to a new function. Analyses and studies were carried out mostly in situ; however, written archival resources were also a valuable source of knowledge. The materials used during the study include e.g.: handbooks and manuals on military buildings issued by institutions of the Austro-Hungarian Empire, concerning material technology, types of structures, colour, and camouflage.

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After the partition of Poland in 1772 Cracow became a part of the Austrian Empire. In 1850 under the decision of the Austrian Emperor Franz Joseph I to turn the city into a fortress, the first modern fortifications were developed. At the beginning of the World War I, Cracow was the largest fortified city in this part of Europe, with over 50 built forts, as well as batteries, earthworks, and other military structures, such as barracks, hospitals, gates, and shelters [1, 2]. It should be noted that at that time it was not the only fortified city in the Austro-Hungarian monarchy. Similar ring fortresses were established in Przemyśl (now in Poland), Pula (Croatia), and Kotor (Montenegro); the one in Cracow, however, can be considered as a prominent example [3–6].

For several decades, the Austro-Hungarian military heritage in Poland was neglected and known only to a group of specialists and enthusiasts. Up to the 1990s only a few centrally located objects of the Cracow Fortress were under legal protection of the Polish Monument Register, while the majority of them were not utilised, or lacked proper conservation [7]. In recent years Poland has seen a certain increased interest in the military past of towns and cities. Tourist routes following former forts are being organised, many structures regain their former glory and get adapted to public functions, such as museums or culture centres [8–11]. The reuse of heritage buildings is being discussed worldwide, and according to a study by J. Djebbour and R. Barra it is substantial to determine their proper function through a complex decision-making process [12].

Measures are also undertaken aiming at valorisation and protection of fortified landscapes as important components of the urban identity [13]. There are ongoing discussions on the appropriate use of existing fortification complexes. These measures fit in a wider global trend of commemorating and raising awareness of the events of the World War I, within the scheme of which numerous fortresses get revalorised and open to visitors [14-17]. In addition, in recent years cultural tourism oriented towards military heritage attractions has increased substantially, becoming a driving force for further transformations of the existing substance [13, 14].

Despite the above-mentioned growing awareness of the importance of the Great War's cultural heritage, a relatively small body of research devoted to conservation problems mentioned in this study can be found. The most significant contribution comes from writings by J. Bogdanowski, who - among his other pursuits - explored early modern fortifications of Cracow as valuable components of urban and architectural heritage of the city [4–6]. More recent publications by K. Wielgus and J. Środólska-Wielgus concentrate on problems of systematic protection and adaptation of existing structures to new functions. According to the existing studies, the value of the fortifications is strongly connected with camouflage greenery and landscape formations, which can play a vital role in the shaping of current systems of green areas [15–17].

The current state of structures belonging to the Cracow Fortress is diversified. There are 9 forts that have been developed and used, renovation works on the next several of them are currently in progress. Sadly, some of these structures were demolished in the 1950s and 60s, and many are very devastated. One of the forts that have been renovated only recently is the Swoszowice Fort, chosen as a case study herein.

The aim of this study is to bring attention to issues relating to the 19th-century military heritage, which to the best of our knowledge is still not widely represented in international research. The majority of publications examine the overall value of post-military complexes in creating the identity of the place or of the whole city. It is a problem of great importance; nevertheless, in our opinion the research on late 19th-century fortifications should also focus on a more detailed study of materials and technologies applied, which are specific and unique to those types of structures.

Therefore, two main groups of problems can be identified in the process of conservation and restoration of fort buildings. The first group is directly related to the technical condition of materials, their deterioration, or devastation. The other group of problems can be associated with the original purpose of the building. After the fort had been demilitarised, it was subjected to

some rough modifications in order for it to serve a new function. Additional partitions or openings were created and some of the original elements were removed due to their deterioration or value as recyclable materials. Hence, it was necessary to clarify the functional layout of the building, as well as the condition of its elevations.

Materials and Methods

Case study selection –Swoszowice Fort

Swoszowice Fort (previously used name: Wróblowice), located at the current Sawiczewskich street in Cracow (Fig. 1), was erected in 1897-1898, within the scheme of transformation and reinforcement of the Cracow Fortress implemented in the late 19th century and early 20th century (1896-1898 and 1902). This period saw a considerable reinforcement of the so-called 7th fortress defence sector. The main artillery forts: in Prokocim (Fort 50) and Rajsko (Fort 51) had their interfields reinforced with four small, armoured forts: Lasówka Fort (50a), and a group of forts located in Wieliczka Foothills – Forts 50 1/2 O and W – Kosocice, and Fort 51 1/2 Swoszowice. The Swoszowice Fort was an armoured close-in defence fort, furnished with an armoured observation tower (since 1894) and four armoured turrets equipped with guns. The fort was built according to a design by a military engineer, Lieutenant General Joseph Ritter von Greiffenthal Reyl-Hanisch, an officer of the Cracow-based Engineering Directorate [22].

Fig. 1. Scheme of the Cracow Fortress in 1916. Location of the Swoszowice Fort is marked in red.

After the World War II the fort belonged to the city of Cracow until 2013. Initially, it was used as a civil defence warehouse, subsequently as premises of the municipal archives. It has been the property of the State Treasury since 2016. It is an example of the development of military architecture from that period, characteristic for fortifications erected within the territory of the Austro-Hungarian Monarchy at the turn of the 19th century. The Fort was entered in the register of monuments under the number A-1303/M only in 2012 [7]

Today the building is administered by its lessee, the Gloria Fortibus Foundation, which through its activities has crucially contributed to the restoration of the Fort, organising the

Museum of Military Affairs here. The Museum allows patrons interested in the World War I to learn about the significance of the Cracow Fortress in the warfare on the eastern frontline. In order to adjust the Fort to its new function, it was subjected to thorough renovation and restoration works, including e.g.: construction of new partition walls, removal of secondary brickwork, as well as – after the removal of the roof – reconstruction of the balustrade and the platform on the shooting gallery. A significant part of the works was the conservatory renovation of brick elevations and of concrete and steel elements which required renovation or partial reconstruction.

The descriptive methodology was chosen as a best tool to decribe and illustrate the selected case. This methodology allows us to present the urban and historical context as well as the initial conditions and the scope of works. The main scope of renovation and conservatory works presented in this paper concerned the exposure and reconstruction of the concrete shooting gallery on the flat roof of the fort. Conservatory works also covered the elevations of the barracks, restoring the original colour of bricks and armoured doors and window shutters. All preserved metal elements, such as railings and balustrades, underwent conservatory works. All missing or corroded components were added and reconstructed.

All the aspects: the functional layout of the fort, the disposition of the elevations, and forms of individual elements had a profound military justification. Therefore, the authors analysed archival sources in order to determine the original layout and functions of individual rooms, their furnishings, as well as the plausible colours used on the elevations, which were subsequently confronted with results of stratigraphic tests.

The following archival sources were used, some of them constituting fortification theory handbooks:

1. Brunner M. (son), 1909, *Die beständige Befestigung. Für die k. u k. Militärbildungsanstalten und zum Selbstunterrichte für Offiziere aller Waffen*, Wien.
2. Leithner E., 1899, *Beständige Befestigung und der Festungskrieg*, III. Band *NeuesteAnschauungen,* Wien.

More detailed information was provided in design instructions and guidelines:

1. K. u k. Technisches Militär-Comité, *Projektsbehelf No14. Anhaltspunkte über Einrichtung von Sprachrohrleitungen,* Vienna 1897. KA Wien, sygn. GS k. 733.
   Guidelines on the application of communication installations by means of speaking tubes.
2. K. u k. Technisches Militär-Comité, *Projektsbehelf No 15. Beschreibung der Panzerlafette für die 7'5 cm Schnellfeuerkanone,* Vienna 1894. KA Wien, sygn. GS k. 733.
   Description of the turret – armoured 8 cm M.94 PK cannon tow truck and guidelines of its installation on the flat roof of the fort, with a set of technical drawings and drawings of details.
3. K. u k. Technisches Militär-Comité, *Projektsbehelf No16. I. Teil: Direktiven für die Konstruktion permanenter, bombensichererKriegshohlbauten*, Wien 1904. KA. Wien, file ref. GS k. 733. Guidelines to dimensioning and material solutions for walls and flat roofs in fortification facilities with the resistance class *bombensicher* (attacks of heavy artillery plunging fire missiles).
4. K. u k. Technisches Militär-Comité, *Projektsbehelf No 17. Beschreibung der drehbaren gepanzerten Beobachtungsstände mit Klauenring mit der Widerstandsfähigkeit gegen Belagerungs-Geschütze,* Vienna 1898. KA Wien, file ref. GS k. 733.
   Description of the observation tower and guidelines for its installation on the flat roof of the fort, along with a set of technical drawings and drawings of details.
5. K. u k. Technisches Militär-Comité, *Projektsbehelf No34. Abdichten von Betondecken bei Kriegs-Hohlbauten*, Wien 1902.
   Description of the technology of the anti-moisture insulation on concrete flat roofs of forts.

The authors also analysed archival reports, plans, and designs relating to the fort in question:

1. K. u k. Festung Krakau, *Ausrüstungs Generalentwurf*, mobilisation plan of the Cracow Fortress. Cracow, March 1914; KA Wien, file ref. NFA FP FK k.1443. Table with a description of staff, armament, and tactical tasks of individual structures of the Cracow Fortress, including the Wróblowice Fort.
2. K. u k. Geniedirektion in Krakau, *Übersichtsplan des Gürtelhauptwerkes "Wróblowice"*, site plan scale 1:800, floor plans and sections scale 1:400. Cracow, December 1989, update February 1914; KA Wien, file ref. NFA FP FK k.1443. General plan of the fort, illustrating the original form of the ground parts, division into individual rooms, with a tabular summary and description of their original functions.
3. K. u k. Technisches Militär-Comité, *Programm für der Ablieferung der Panzerobjecte*, Vienna, January 1898.

Schedule of supplies of armoured elements (observation and artillery towers) for fortresses in Galicia (Cracow and Przemyśl).

4. Operatives Bureau des k. u k. Generalstabes, *Auszug aus den Situationsberichten der Genie-Directionen über den Stand der Befestigungsbauten…;* Ead., *Auszug aus den Situationsberichten über den Stand der forttif. Arbeiten…,* ib.*;* Ead., *Situations-Berichte über den Stand der fortificatorischen Verstärkungsma_nahmen.* Vienna 1898-1899; KA Wien, file ref. GStb OP.

Periodical quarterly tables, with descriptions of implemented and planned works at the construction of the fort.

Results

Initial conditions

In its original state, the fort was intended for close-in defence. The building of the fort baracks has two floors and is covered with a concrete flat roof. It was executed in line of the then requirements valid for fortification structures: the 2.2m-thick southern wall as a wall receiving the first hit was made of fortress concrete and limestone. At the foundations level there was a rainwater drainage canal. The wall was covered with soil from the south and equipped with a stone detonation flame arrester. The 1.05-1.20m-thick northern wall was made of bricks and mortar, arranged in compliance with fortification guidelines.

The fort was built in the resistance class against heavy artillery plunging fire missiles (*Bombensicher*). On the flat roof there was an armoured observation tower and four turrets – platforms for rapid-fire guns. The access road and the entrance to the fort were protected with an earthern tower, a guardhouse in the neck, as well as two gates and a fortress lattice. At the forehead and shoulders of the fort there was a shallow moat with a flattened slope, bombarded from the embankment with the straight fire. Due to the specific location of the fort on a hill slope, there is no moat in the neck section. A considerable part of the neck, however, is enclosed in a long retaining wall. Furthermore, the massif of the fort was surrounded with a belt of permanent obstacles – wire barriers.

The concrete roof with a stepped shape fulfilled the role of a shooting gallery. Shooters were protected by a concrete parapet, equipped with small niches for handheld ammunition. On the edge between the vertical parapet and the slope of the flat roof towards the moat there was a small recess for elbows – an elbowrest. Quick and secure communications with the barrack interiors were secured by three passageways located behind the parapet, along the communication line of the gallery. Entrances were shielded with armoured metal doors, mounted on the edge of the ceiling over the elevation of the barracks.

After the war, the fort was subjected to alterations to adjust it to current practical purposes. The brick walls were plastered. After the disassembly of the armoured turrets in the 1970s and 1980s the openings after the domes were sealed with concrete, and a coal chute and a boiler room chimney were added. At the same time, the concrete shooting gallery was covered with a mono-

pitched roof based on a wooden structure and covered with galvanised steel sheets, with technical supporting walls made of machine-made ceramic bricks, spaced apart in order to secure ventilation. As stated by J. Bogdanowski in his publication form 1966, "(...) the architecture of the fort remained unchanged – simple, functional, with red brick walls, grey arches of vaults or plates visible outside". [6]

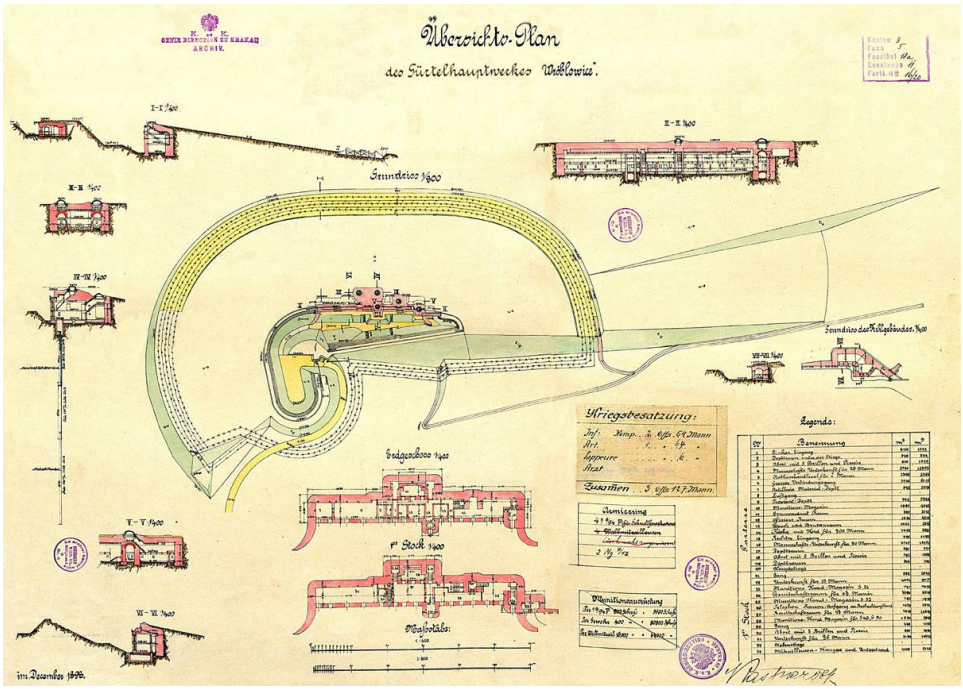

Fig. 2. Archive plan of the Fort from 1898. K. u k. Geniedirektion in Krakau, Übersichtsplan des Gürtelhauptwerkes "Wróblowice", site plan scale 1:800, floor plans and sections scale 1:400. Cracow, December 1989, update February 1914; KA Wien, file ref. NFA FP FK k.1443

Despite the changes introduced in the second half of the 20th century, the form of the building and its layout remained legible and relatively well preserved. The facility lacked its original military equipment, including armoured fittings, internal stairs onto passageways to the shooting gallery. There were no armoured doors and armoured window shutters, as well as the majority of internal doors were missing. It should be pointed out that the use of the fort and difficult access to it for unathorised individuals protected it from any major damage, including acts of vandalism. The shooting gallery as well as the elevations of the fort were partly protected against weather conditions.

Based on the analysis of archival sources, it has been concluded that the Austro-Hungarian army tried different façade paints at least until 1897, so as to provide proper camouflage resistant to weather conditions. Principally, the desired paint was to be similar in colour to the colours of the surroundings to allow the fortifications to blend into the landscape. Such experiments were conducted in all fortresses of the monarchy. In Cracow, there were experiments with covering brick walls with water-based grey-green paint by Winter&Weinmann. Concrete and metal-clad flat roofs, on the other hand, were covered with oil paints by Lutz (three-colour camouflage of grey, brown, and dark green spots) and anti-corrosive paint by Bessemer in green [18, 19]. There were attempts at using a layer of sanded tar as a primer. In their trials, the Austrian army concluded that even the most durable paint had to be reapplied every three years due to colour fading.

Stratigraphy

Prior to restoration works, lab tests were conducted on samples of plasters and mortars. Stratigraphic and opencast studies were performed on the walls and ceilings of the shooting gallery and the preserved metalwork of the fort (balustrade, doorframes, steel structure inside), and they allowed to specify the colours and technology applied on surfaces of concrete and metal elements. The studies were performed in two stages: before the works, and after the disassembly of non-original elements. Samples of plasters with layering were subjected to stratigraphic and microscopic tests in order to determine the order of layers. The tests were performed by means of the USB microscope in magnifications of 50-200x. The layers were identified with the application of microscopic and microchemical methods. It was expected to determine the original colours of the elevations as guidelines for subsequent restoration works (Laboratory tests were performed by "Pracownia Badań Laboratoryjno-Konserwatorskich Barbary Sowy-Holewińskiej w Krakowie".).

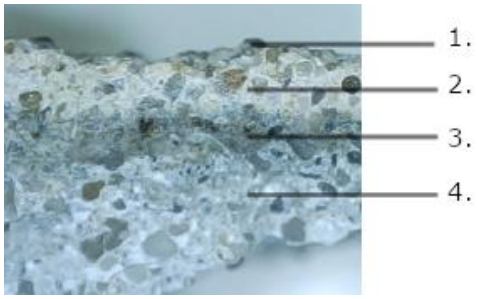

Fig. 3. Stratigraphy revealed subsequent layers: 1. Glazed remains of a sanded layer, body-tinted plaster; 2. A ligh pink-ochre layer; 3. A dark grey layer (most probably cement milk); 4. Plaster

The microscope revealed fragments of layers – sanding and paint layers, lossened, glazed, mixed with clusters of crystallised salts. The samples contained traces of chrome green, grey (white with black), and traces of the iron pigment – ochre. The samples collected from masonry joints constituted hard, grey lime-cement mortars, with a layer of tar on the surface.

Regarding the metalworks, tests were carried out in 8 locations: on preserved fragments of a balustrade, window frames, and the metal interior structure.

Tests on the balustrade (Fig. 4a and b), revealed the presence of 5 technological layers in 4 historical layers. The oldest preserved historical layer applied on red lead was a layer of graphite grey paint, painted smoothly, similar to the colour NCS S 6500 – N. On other metal elements (Fig. 4c-f) 6 technological layers in 5 historical layers were revealed, with the oldest preserved paint layer on the red lead primer in the colour of Roman cement. On it, there was a layer of greenish light grey paint, similar to the colour RAL Kieselgrau 7032, next a layer of dark grey paint with a touch of blue, similar to the colour RAL Basaltgrau 7012, then another layer of paint in RAL Kieselgrau 7032. The last chronological layer repeated the colour RAL Basaltgrau 7012 or RAL Eisengrau 7011.

Concrete

Issues associated with the conservation of concrete elements related predominantly to the shooting gallery on the roof of the building. As it is known from archival materials, in an Austrian armoured fort *Gürtelwerk* (girdle works or fortress girdle) it was an open shooting position for infantry with a concrete parapet, located on the flat roof of the barracks behind the line of artillery turrets [3]. The concrete used in the shooting tower was prepared according to the guidelines for the so-called *fortification concrete.* On the basis of archival guidelines, it was concluded that it contained grit fractions, including limestone aggregate, silt fraction, and cement [20].

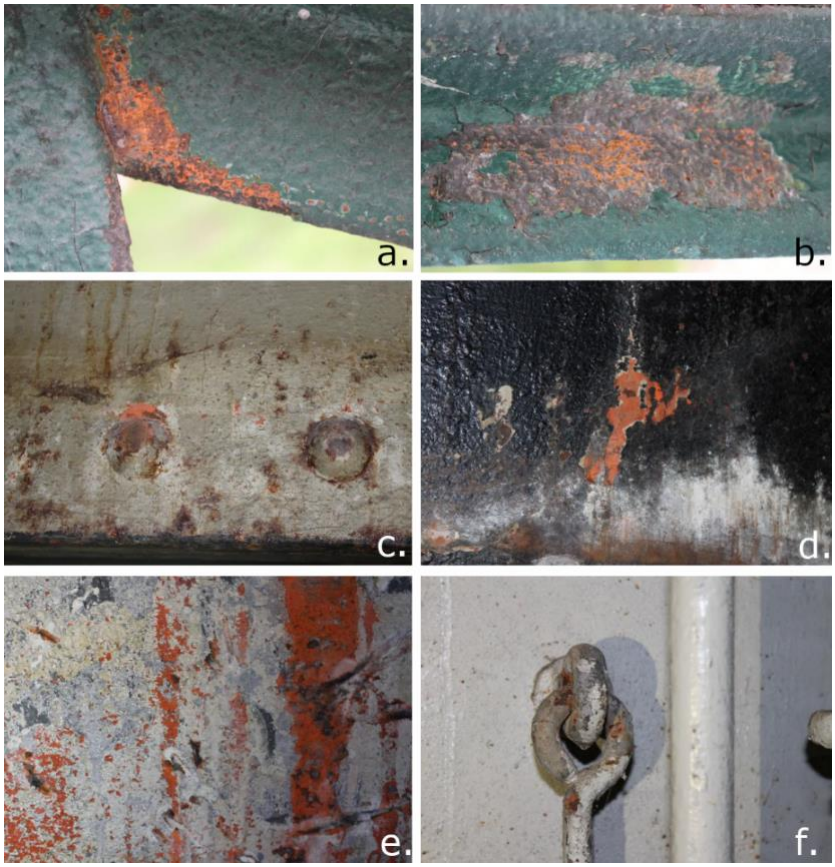

Fig. 4. Stratigraphic tests of the metalworks: a, b – the balustrade; c, d, e, f – other metal elements, such as door frames, window frames, and the metal interior structure

A condition for repairs of damaged concrete surfaces to be durable is the application of an appropriate technology and a durable material, which will not age quickly losing its mechanical properties, as well as have a number of physical properties, characterised by – among other things – high frost resistance, tightness, and abrasion susceptibility, as well as low water absorption. These are not, however, sufficient conditions, as a durable material is not enough for the mortar to be durable, too. Conservation materials must cooperate well with the concrete used in the repaired structure. The area of the conservatory repair of concrete needs to be regarded as a certain system, consisting of the old existing crushed stone and a new filling material, as well as a zone of contact of both materials. As stated by L. Courard *et al.* [21], "efficiency and durability of a repaired system depends on the bond between concrete substrate and repair material". According to the existing knowledge on repair of concrete elements, the most commonly used solution is the application of the so-called bonding (priming) layers, which improve adhesion and eliminate emerging stresses.

It has been stated that corrosion of gravel concrete in the fortress structure in question was predominantly caused by precipitation: rain and snow. The reason for this corrosion is the leaching action typical for soft waters. Rainwater is a good solvent for calcium hydroxide and carbonate. Physical properties of rainwater consist in its penetration into gravel concrete and dissolving some of its ingredients, which settle on the concrete surface after the solution percolates through this material, forming an additional layer, different from the concrete. At the same time, the internal structure of gravel concrete becomes porous and has lower strength. This

is how the so-called weathering bark appears. This bark is usually brittle and peels over time. Layers of concrete underneath the bark also gradually brittle and peel. This way the weathering of concrete progresses deeper, and the bigger the temperature changes and the more aggressive the substances dissolved in water, the faster the weathering of concrete progresses [22].

The concrete weathering observed in the layer of the flat roof of the caponier and in the flat roof of the barracks is characterised by a change of colour of the outer layer and the spots and lichens that cover it. Even though microbiological corrosion refers predominantly to organic materials, it also appears on concrete and it may cause further degradation [23, 24].

During the works it was possible to inspect in detail the technical condition of the gallery after the disassembly of the secondary roofing (Fig. 5). The concrete there was covered with a layer of dirt caused by weather conditions. The inspection also revealed cracks and a moderate degree of concrete corrosion, sometimes cavities in the aggregate revealing thicker aggregate fractions (gravel). Concrete elements of the gallery were covered with mortars and brick walls which were used for the roofing. Niches for bullets were partly bricked up and sealed with mortar, and technical openings for fitting steel sheets were sealed with wooden pegs and mortar.

Fig. 5. The condition of the shooting gallery after the disassembly of the roof (a.) and during conservatory works (b.).

During the works the secondary fillings and walls covering some niches were removed in order to restore the original disposition. The concrete surface was cleared of all secondary mortars. Corroded fragments of concrete were removed mechanically. The surface was cleared by means of abrasive blasting, repainted layers were removed, cracks were filled up with mass based on the cement binder modified with Sto Crete BE Haftbrücke polymers by Sto. A repair and reprofiling layer were applied by means of ribbed steel wire clamps protected with anti-corrosive aerosol. Bigger cavities and cracks in concrete were filled with mortar based on hydraulic cement. A two-component waterproofing layer was applied, consisting of acrylic mass with the addition of Portland cement with an embedded armoured reinforcement mesh and anti-alkaline impregnation. Vertical planes of the flat roofs were levelled and provided it with a texture and character as close as possible to the original surface of the natural fortress concrete. To this end, mineral mass reinforced with glass microfibre Faserputz by Sto was used. Water draining canals in the concrete flooring of the gallery by the passageways were uncovered and preserved.

Colour samples were matched to the results of the stratigraphic and opencast tests. During the construction of the fort (1897-1989) the flat roof was executed as a concrete one. Several seasons after building armoured forts of this class (thirteen forts were built in Cracow in 1895-1899) it turned out that the flat roofs had to be additionally insulated against precipitation. In 1902 a special technical instruction was issued focusing on sealing concrete flat roofs [25]. Therefore, after 1902 zink plate standing seam roofing was made. Thanks to this, despite numerous subsequent repaintings of the cover, the oldest colour versions of the concrete were preserved. A double glaze was made by applying silicate paint by Keim – mixed colours S 113 (3 parts), 9007 (1 part), S 187 (1 part), S 070 (1 part), fixative (2 parts). The mixing of colours resulted in warm grey with an addition of and ochre-based hue. Test results are in line with the findings of researchers from the 1960s, when the remains of the original paints were still legible: "(…) What is new is the paint camouflage, introducing the colour of light sand on the walls, sometimes with black spots, and dark ochre for the towers and armoured surfaces" [6].

Brick elevations

The bricks of the elevations were covered with a layer of dirt caused by weather conditions and repainted with green oil paint. In several places a yellow layer was visible from underneath the green paint. It is in line with Austro-Hungarian guidelines on paining elevations of forts in the Przemyśl Fortress – the walls were painted with perishable paints so that the colour of the elevations could be changed depending on the seasons (green in summer, most probably white in winter). This served the purposes of camouflage. In the Swoszowice Fort it was decided to restore the natural colour of bricks, without any camouflaging painting.

Some of the bricks were corroded, there were cracks and cavities in the wall structure, there were also fillings with cement-lime mortar visible. The eastern part of the barracks had not been protected against dampness, a considerable crack requiring to be repaired was noticed (Fig. 6).

Fig. 6. Condition of the eastern elevation prior to the commencement of works (a.) and after their completion (b.). Visible repainting, cracks, and cavities in the brick wall, as well as altered brickwork and sizes of openings.

It should be pointed out that brick walls (Fig. 7) of the fort were made in line with fortress building rules, i.e., only the heads are visible, all wall layers are the same. Joints between adjacent layers are shifted relative to each other by half the width of the brick (by half of the head). Due to the high strength of the wall, this method was used to build walls of forts, citadels, and other defence facilities. Further development of artillery, however, forced a departure from bricks in favour of more durable materials, most of all reinforced concrete and steel.

Fig. 7. The way of arranging bricks with the head facing the front of the wall. The so-called fortress binding of the wall (*Fortifikatorischer Verband*), Source of illustration: *Constructions-Details der Kriegs-Baukunst, Band I.*, Wien 1878; Table No. 4 "Mauern, verschiedene Ziegel-Verbände".

In order to liquidate the oil paint layer, attempts were carried out to jet clean the bricks by means of different methods: hydrodynamic, chemical, abrasive blasting with quartz dust, abrasive blasting with a biological agent. The mechanical cleaning method can lead to surface damage, however, as observed by S. Samolik et al; brick in general is less fragile than plaster or limestone. Therefore, despite its disadvantages mechanical cleaning is often chosen as the basic method of removing the unwanted layers, due to its simplicity and low costs [26]. Eventually, low pressure abrasive blasting was chosen, varied depending on the strength of bricks, by means of quartz dust and biological cleaning Gumage. This way oil layers and dirt caused by weather conditions were removed from the bricks. Corroded bricks and joints around the main entrance to the fort and around certain window frames were removed mechanically by manual chipping. Secondary walls in the eastern part of the barracks were eliminated, as well. Graded spraying impregnation was applied with the use of impregnates for strengfthening weathered and loosened surfaces, based on ethyl esters and silicic acid KSE 100 and KSE 300 HV by Remmers.

As it turned out, it was necessary to reconstruct the brickwork. To this end full construction bricks were used, arranged in compliance with the principles of fortress brickwork. Cavities in bricks and joints were filled with a body-tinted mineral mixture in local colours by Hufgard Optolith and Optosan TrassFuge. The colours of putties and discolourations were merged with original colours of individual bricks by means of silicate glazing Restauro Lasur by Keim and a silicate binder to glazings Optomal fixative by Hufgard Optolith. For the purposes of protection against weather conditions, brickwork hydrophobisation was carried out using the silane-siloxane solvent preparation Funcosil SL by Remmers.

Metalwork

In the fort 51 1/2 Swoszowice one deals with numerous steel elements constituting both the structure of the fort and the military fittings of the barracks. These are – without limitations:

a. Ceiling elements;
b. Armoured artillery turrets and the observation tower on the roof of the building;
c. Doors and window shutters;
d. Balustrades, ventilation grills, and other minor elements.

The main structural elements of the ceiling above the ground floor and the first floor are riveted steel tee-bars combined into an I-section. As a result of the adaptation for the purposes of archives after the war, the surface layer was replaced with a reinforced concrete ceiling, leaving the original I-sections. In the ceiling above the first floor there are steel arches supported by the I-sections – on them there rests the concrete cap of the fort. Steel beams and arches on the first floor were completely covered from the bottom after the war. Thanks to that, the steel structure was preserved in a good condition, with only minor traces of surface corrosion visible. On the basis of a fragment of the original paintwork under the observation tower, the colour of the topcoat was selected: RAL 1014 Elfenbein.

Armoured artillery turrets and the observation tower on the roof of the building constituted the original elements of the fort. The armoured tower belonged to typical fort fittings. It was a rotating steel dome, protecting staff from the enemy's bullets, and at the same time allowing to

fire the guns installed in it. The dome of the tower was supported on a forearmour and a rolling bearing, which enabled to rotate the tower horizontally [4].

Cast steel armoured domes have not been preserved – they were diassembled in the second half of the 20th century. The forearmour has been preserved – consisting of two parts: the upper girdle (equipped with a track, bearings, and a gutter), and the lower girdle (segmengted, with characteristic niches on its perimeter). The sequence of niches was interrupted with a profile to be joined to the armoured vault above the entrance. Additionally, the armoured vault – an element with the profile of a basket arch over the stairs to the tower reinforced the concrete part of the vault. All these elements were made of cast steel. The state of preservation was average, the outer layer of metal had been destroyed (Fig. 8). An additional factor with a negative effect on the condition of steel elements was lack of appropriate ventilation in the towers and concentration of steam.

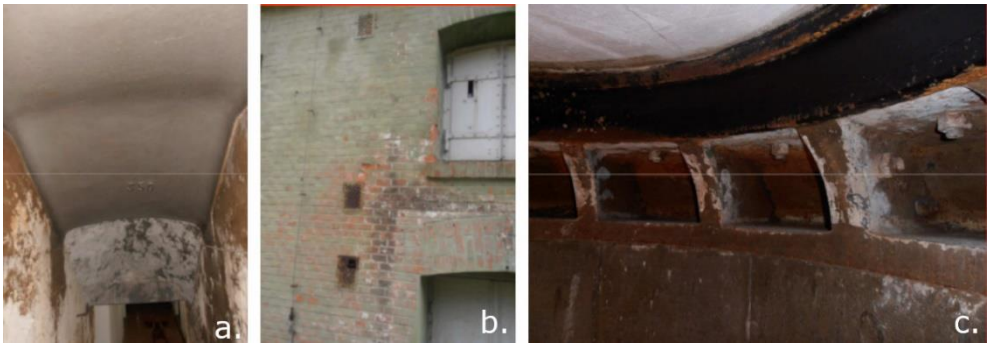

Fig. 8. The condition of preservation of metal elements. A-Visible armoured vault to the artillery turret S50; b – Fragment of the elevation of the barracks – visible ventilation grills; c – the upper girdle of the forearmour in the turret S50. Source of illustration: authors' photo.

Most original armoured doors and window shutters were preserved, and they required only conservatory measures. Steel elements intended for conservation were cleaned of oxide corrosion elements by sanding and manual mechanical methods. Steel roofs above door openings and armoured doors were renovated. The designs were prepared on the basis of relics found in opencast studies and by analogy to preserved leaves of armoured doors on the ground floor. The tee-bar balustrate was recreated, maintaining the spacing of supports in compliance with preserved relics of fittings. Missing rivets in the metal joinery of entrance openings to the passageways were added, too. Chlorinated rubber primer paint Everal Extra 80 by Tikkurilla was applied. The balustrade was painted graphite grey smoothly (according to the shade guide of Lowigraf steel-graphite 95, 131-7754-03-95-XX-1, other metal elements were close to the colour RAL Kieselgrau 7032, in line with the results of stratigraphic tests.

Discussion

The aim of the study is to bring attention to some of the characteristics of the post-military object which should be taken into account when planning restoration processes. This study presents some selected problems related to conservation work on the object –Swoszowice Fort, a part of 19th-century fortifications. The problems mentioned above included general decay and deterioration of materials as well as functional changes and removal of original military equipement. It was found necessary to perform additional research on the conditions and guidelines concerning 19th-century fortifications in order to reconstruct the interior divisions and the missing equipement.

As of the commencement of the conservation works, the Swoszowice Fort was in a good technical condition, despite the lack of professional ongoing conservation. This situation results from the fact that the facility was in constant use and was inaccesible to unathorised individuals.

Nevertheless, numerous defence facilities of the Cracow Fotress have been still falling into decay, devastation, and oblivion.

Furthermore, some researchers believe that cultural heritage associated with warfare tends to be regarded as undesirable, as it relates to a historically significant, but difficult past [27, 28] To a certain extent this applies to the Polish reality, since Poland until 1918 was under partitions and did not exist as a sovereign country. Therefore, the Austro-Hungarian military legacy was underrated for a long time.

Conclusions

In light of the existing research, it is clear, that the problems associated with military heritage of the former Austro-Hungarian monarchy are not widely represented in literature. Therefore, this paper fills the gap by providing insights into current situation on the example of one of the objects belonging to the Krakow Fortress with particular focus on technical conditions.

The process of conservation and restoration of the Swoszowice Fort was explained to present a broader perspective on issues related with the existing post-military structure. During the analysis of the selected case, it was found that the original purpose of the building was an important factor in determining the further conservation strategy. The analysis of the materials, as well as the analysis of the archival resources allowed for the identification of the technologies specific for the 19th-century fortifications. Additionally, the architectural project was prepared in order to adapt the building to a public function.

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