



NAME OF THE INVESTMENT:	REVITALISATION OF THE KING BASTION – A PART OF THE KOSTRZYN FORTRESS – FOR CULTURAL PURPOSES	
ADDRESS:	Bastion King, Zespół Fortyfikacji Twierdzy Kostrzyn, plot No. 75/3, K. nad Odrą	
INVESTOR:	City Kostrzyn nad Odrą, Ul. Graniczna 2 66-470 Kostrzyn nad Odrą	
PHASE:	ARCHITECTURAL RESEARCH REPORT	28 February 2014
PREPARED BY:	Janusz Nekanda-Trepka, MSc Eng architect	

Documentation prepared for the project 'FORTE CULTURA Capitalizing of fortified cultural heritage for sustainable development and competitiveness of cities and regions' implemented through the CENTRAL EUROPE Programme co-financed by the ERDF.

Lead partner of the Forte Cultura project:

Town Hall Kostrzyn nad Odrą

ul. Graniczna 2

66-470 Kostrzyn nad Odrą

+48 95 727 81 24

+48 95 727 81 93

mail: [fortecultura@wp.pl](mailto:fortecultura@wp.pl)

<http://www.forte-cultura-project.eu/>

**FEBRUARY 2014**

Biuro Projektowo – Inżynierskie REDAN Sp. z o.o.

ul. Jagiellońska 69, 70-382 Szczecin, Tel.: (091) 462-40-91, Fax. (091) 462-40-43

## ARCHITECTURAL RESEARCH REPORT

The system of the military structures of the King Bastion in the modern fortress of Kostrzyn nad Odrą in the Lubuskie Region (*Festung Küstrin in der Neumark*), entered in the register of monuments under No. KOK – I – 81/76 on 2 November 1976, consisting of: the curtain from the Berlin Gate to the right flank of the King Bastion, the shoulder, fronts and the left flank with the remains of the shoulder and the curtain in the direction of the Brandenburg Bastion, cavalier with the level of storage rooms and shoulder casemates, posterns and gunpowder storage rooms.

The architectural study included the cavalier building and its interior at level '-1' and level '-2', along with the casemates of the right shoulder. The remnants of the casemates of the left shoulder and the postern leading to it have only been described without measurements due to their unavailability (no inventory of the remnants). The backfill over the fragment of the casemates of the right shoulder was examined using the opencast method, and the structure of the backfill in the undeveloped part between the cavalier and the front of the curtain from the side of the moat was surveyed on the basis of drilling examinations.

The study was conducted in February 2014 on the basis of the decision of the Lubuskie Region Monuments Conservator, Branch in Gorzów Wlkp. No. ZN-G.5162.1.2013 of 14 February 2014, based on the architectural inventory in the scale of 1:100, prepared in 2013 on the basis of a 3D scan by the 3 Design Studio Gerard Wełniak from Leszno and the archival materials from the collection of the Kostrzyn Fortress Museum. In the absence of an indication of the level above the sea of ordinate 0.00 in the inventory, the level of 0.00 was adopted in the research description as interpolated from the situation and height backing as **22.50m a.s.l.**

Contracting Authority: Town Hall Kostrzyn nad Odrą, ul. Kopernika 1; 66-470 Kostrzyn nad Odrą.

### Scope and Purpose of the Examinations:

Examinations have been carried out within the scope determined in the contract in the description of the subject matter of the order – conducting architectural and conservation examinations in order to determine the relative chronology of the historical elements of the structure, the applied techniques and construction

technologies (including brick laying, lime, masonry, and plastering works), ventilation and drainage, referring to the results of research on the techniques and technologies characteristic for the art of fortification in the given period.

The aim of the examinations is to determine the conservation concept of protecting the bastion, including the conclusions and conservation guidelines, defining the operating conditions of the interior of the casemates, the way of using the existing partially closed shafts and ventilation ducts, proposing a strategy of exhibiting the identified historical and functional layers of the facility.

## **1. Description of the Examined Buildings and their Surroundings.**

### **1.1. Surroundings**

The outline of the bastion consists of frontal and flank curtains of the same relative height of about 10m over the terrain level, set at an acute angle, the north-western curtain is directed to the moat, and the south-western one is parallel to the stream of the Oder River. The neck of the bastion is an elevation between the curtain connecting the right shoulder of the bastion with the Berlin Gate and the curtain (demolished) between the left shoulder and the Brandenburg bastion; the elevation of the neck is connected with a road traverse from the level of the town streets, at which an entrance to the postern was preserved, leading to the casemates of the left shoulder, and then to the remaining casemates under the cavalier and the right shoulder.

On the terrace of the bastion, levelled after 1945, there is the upper part of the cavalier with the levelled breastwork elements, elevated over the terrace level by about 3m. The main maidan of the bastion has preserved remains of a war cemetery and green belts and railings on the buttress crown; the cavalier terrace is overgrown with shrubs and self-seeding trees. The shoulders of the bastion have casemates, the right shoulder is preserved and the left one was destroyed in the last days of World War II.

The bastion is in contact with the destroyed old town buildings which indicate cleared street and square hallways and the building quarters are filled with rubble. In the closest vicinity of the bastion there are the restored Berlin Gate performing tourism functions and rebuilt coffer dam of the moat, in contact with the national road No. 22, leading to the border bridge over the Oder River, and from the south,, partially furnished walking route along the Oder River to the improved Philip Bastion in which there is the exhibition of the Kostrzyn Fortress Museum.

### **1.2. Buildings**

The only cubature facility elevated over the level of the terrace is the aforementioned cavalier with the rectangular projection of 39 x 17m, the façades of which are sloped from the vertical and lined with ceramic bricks to the thickness of  $\frac{1}{2}$  of the brick on the cement mortar, only the north-western façade is enclosed with a brick composition with elements of a cemetery style. The inside of the cavalier includes two levels of rooms, three rooms at the level of 18.50m a.s.l. and 5 (9 with secondary divisions) at the level of – 14.00m a.s.l.

All other building parts are located under the surface of the terrace at almost the same level of about 14.00m a.s.l. and it consists of 4 four rooms in the left shoulder, connected through the rooms in the lower level of the cavalier, with the left shoulder which contains two rooms (with two shooting ranges) at the level of 14.00m a.s.l. – filled with rubble, as well as 6 rooms at the level of 17m a.s.l., including the postern with the entrance in the neck from the side of the town, at the level of 17.6m a.s.l. Due to the inaccessibility of the remains of the left shoulder, and the lack of their inventory, the description was based on the inventory from 1833.

## **2. State of Research on the King Bastion** (Marcin Wichrowski, MSc)

The first critical descriptive monograph of the town was published in 1913 by a professor Charles Friedrich high school in Kostrzyn, who used a relatively large collection of the archives and cartographic sources from the collection of the Berlin State Library. Unfortunately, the collection of data gathered this way was still too poor to be able to tell more than his predecessors. In the 1960s, the topic of the genesis and development of the Kostrzyn fortifications was undertaken by the first Polish scholar – Jerzy Stankiewicz. He devoted a separate contribution to the fortress, which constituted almost a canonical work for many years. The demolition of most of the 16<sup>th</sup> century fortifications after World War I (the Prince Bastion with a unique two-storey cavalier collapsed as the last one in 1931) focussed the attention of the scholars on the two remains of the oldest phase of fortress development: the Philip and King Bastions. In the case of the latter one, they were faced with an extremely difficult task: the bastion had examples of technical solutions characteristic for Italian, Dutch, French, and Prussian engineers active in Kostrzyn, whereas the sources relating to it were scarce (in proportion to its duration). This provoked attempts to treat the existing structure itself as the basic source, obtaining significant data from it, which could shed some light on the issue of the fortress construction chronology, starting from 1537. Albert Ludewig, a prominent German amateur scholar, was interested in the bastion already in the inter-war period. The hypotheses recorded in his notes, impossible to corroborate nowadays, are a record of pioneering research in the field of the interpretation of architectural remains of the fortress and the attempts to reconcile them with the available cartographic material,

continued by this scholar in the 1960s. He noticed that the King Bastion includes the remains of all the preceding works of art, at the same time attempting to determine what such works of art could have looked like, on the basis of the archival plans available to him. Krzysztof Biskup, the associate of Jerzy Stankiewicz, had such advantage over Ludewig that he could enter the bastion and conduct a professional assessment of the remains of older works, attempting again to determine their chronology and original shape. Several years later, the theses of K. Biskup were questioned by Daniel Burger in a dissertation published in the year 2000. Based on the broad base of sources, he outlined the process of the birth of the Polish national system of Hohenzollern fortresses in Brandenburg and Franconia, embedding the case of Kostrzyn in the context of the Renaissance military architecture. His merit was also the definitive determination of the time framework of the activity of both Italian engineers who directly influenced the shape of the bastion – Francesco Chiaramelli of Gandino (1559-1578) and Roch Guerini, the count of Linari (1578-1596). Due to the condition and availability of the bastion interiors in the late 1990s, D. Burger could not verify the results of research conducted by K. Biskup, however, he proposed an alternative dating of the early phases of the King Bastion extension differentiated by K. Biskup, based better on written sources, convincingly arguing at the same time with some of the findings of the Polish scholars, especially the ones concerning the date of commencement of the construction of bastion fortifications, and the attribution of their individual components. It is worth noting here that both K. Biskup and D. Burger claimed that the credible, undoubted reconstruction of the works preceding the mature bastion from the late 16<sup>th</sup> century is rather impossible. However, K. Biskup claimed that it is possible to determine the shape given to the first bastion in the period of 1568-71, whereas D. Burger – not rejecting the hypothesis of the predecessor definitely – expressed his opinion that it is necessary to refer them to the period of 1553/54 – 1558.

The issue of the works development over the next few centuries was undertaken in scientific studies, as far as it could provide data helpful to differentiate the older construction phases. The purpose of the present examination of the facility is to briefly report the visible changes in the facility over the last five centuries, with particular emphasis on the transformations which have not been recorded previously.

#### **4. Outline of the History of this Facility (Marcin Wichrowski, MSc)**

The moment of the construction commencement of the Kostrzyn fortifications does which was to take place in 1537 does not arouse controversy. In the opinion of some researchers, the bringing of cannons from Chojna to Kostrzyn in 1543 may suggest the completion of the first fortifications. Little is known about their form. The

existence of earthen walls with positions for firearms seems probable. They were supposed to enable firing from a single point in many directions, in the form of pens or small rondels applied earlier when reinforcing the fortifications of the Brandenburg towns, which were initially relatively unstable, damaged by floods and the descending ice. They were probably reinforced with the application of masonry slopes. The young Margrave proceeded initially to the Schmalkaldic Protestant League, and at that time one of his mentors was the Hessian Landgrave Philip who provided new reinforcements to several facilities, using proven, late-medieval solutions. If John proceeded to build the masonry fortifications already in the 40s, he probably used similar patterns. He could become familiar with the new ideas already in 1547 when he entered the circle of the emperor's military advisors, which included many persons well versed in the latest developments of the fortification art. He could get to know the advantages of the Italian fortifications in 1552 at the latest, when his unit supported the imperial army in the siege of Metz, whose defence used the temporarily erected bastion front. Another extension of the fortress was supposed to begin in 1553/54, which would suggest that John decided to imitate the bastion fortifications. The construction was interrupted several times, and only in 1559, the Margrave manages to acquire an Italian engineer, Francesco Chiaramelli of Gandino, who served the electors of Brandenburg till 1578, building fortresses in Picno, Kostrzyn and Spandau. The chronicle record from the late 17<sup>th</sup> century, in accordance with which Kostrzyn 'only really' (*erst recht*) began to fortify in 1568, was regarded earlier as a mistake, seems to fit surprisingly well to the situation, suggesting that the works at the bastion fortifications were launched on a large scale only at that time.

The inventory of the military equipment stored in Kostrzyn, prepared after the death of the Margrave in spring 1571, enumerates the fortified works existing at that time, whose rooms were used as warehouses. It mentions "a big tower" or "a big mountain from the side of Gorzyn" (*grosser Berg / grosse Postey nach dem Gorin*), which included casemates apart from two vaulted rooms. The inventory enumerates fortified works which could be identified as the later bastions with the names of "King", "Queen" and "Philip", not mentioning the bastions with the names of "Prince" and "Princess" which were probably still under construction at that time.

The only preserved plan of the fortress from that period is a combination of an inventory and an extension projects, which records the completed and almost completed bastions with the names of "Queen", "Prince" and "Princess", as well as the designed bastions on the Oder River. Within the area of the designed "King" bastion the course of the walls of the allegedly existing facilities was indicated, presenting the state of advancement of the fortification works in the middle 1570s, shortly before Chiaramelli left and his duties were taken over by Roch Guerini, the



count of Linari.

The staging of the expansion of fortifications or their replacement with the new ones must have been influenced by the terrain conditions and the intention of maintaining continuity of the existing fortifications. It seems that Chiaramelli found a complete or an almost complete structure similar to a bastion, erected by the Margrave from 1553 in the location of the later 'King' Bastion and resigned from its modifications, regarding this front in Gorzyn, which was the most endangered one with a regular attack, as momentarily sufficiently protected, focusing on the construction of new works at the second most endangered front of Prince – Princess. A reconstruction of the curtains at both shorter sides of the fortress was initiated in 1580, probably taking into consideration the previously completed works.

The first information that raised no doubts, since it was documented by the construction bills, is the 'extension' (*Ausrücken*) of the already existing bastion in the period of 1587-88, as a result of which it acquired its final shape and dimensions, which probably did not change significantly till the 1660s. The works were designed by the count of Linari, and the works on site were supervised by master T. Martinotti. The work received an asymmetrical outline, and its terrace was increased significantly. In contrast with the other bastions, it did not have buttress galleries, but only open flanks with shooting range walls. As a result of the bastion extension, the right orillon grew disproportionately. An open courtyard was performed in the left orillon, which was probably used at that time to introduce shooting points in the partition walls and thus increase the flat operation of the flank battery. It is difficult to determine the organisation of communication with the flank batteries. In the plans there are no traces of any footpaths leading them, and if those existed after all, the would have been preserved as in other bastions. The use of an 'open orillon' in order to bring the ramp to the level of the left flank battery from the bastion terrace seems probable here. The communication with the second battery would be ensured by the rooms over the cavalier. Moreover, Krzysztof Biskup identified a staircase which allowed the people to descend to the left flank from the curtain.

The 2<sup>nd</sup> half of the 17<sup>th</sup> century is one of the least recognised periods of the fortress history; in particular, we do not have indisputable cartographic sources which would allow us to determine clearly the transformation of the whole complex and the bastion. We know with certainty that in the period of 1662-67, the 16<sup>th</sup> century breastworks were replaced with earthen ones in the case of older fortification works, leaving the way for the guards at the external edge of the latter ones, covered with a small wall (more of a barrier than a breastwork) built on the slope. We know the shape of the breastworks owing to the preserved and implemented project of their reconstruction dated 1701, which records the removed

structures. The supervisors of these works were supposed to be engineer Thieleman (Thielemann) and Jungblut (Jungbluth, Jonkbloet) – sometimes considered to be one person. There are no clues that it was limited to the sole replacement of the breastworks, and the King Bastion was reconstructed with the whole fortress in the 60s. The objective was to primarily multiply the artillery stations on the bastion flanks by their accumulation on several levels.

In the years 1667-1693, the works in Kostrzyn were supervised by Cornelis Ryckwaert, a Dutch engineer. A far-reaching reconstruction of the bastions was initiated in the last years of his service, including the vaulting and reconstruction of their flanks into casemates. In 1694, the position after the late Ryckwaert was taken by Jean Louis Cayart, a Huguenot immigrant. The preserved concept sketches indicate that at the moment of taking over the duties, the bastion flanks of the modern front were already vaulted, and the flanks of the King and Philip Bastion were not – omitting the open orillon of the left flank of the former. In the document entitled "Shortened estimation of the works and buildings necessary to be implemented in the town and the fortress of Kostrzyn for its improvement" dated 1701, in this case, in the older estimate of the works planned already in 1694, Cayart only mentions the necessary 'extension of the left flank' of the Philip Bastion (it was at that time called the casemate bastion). The reconstruction and vaulting of the left flank of the King bastion which resulted in the total number of cannon stations, was also connected with the communication of the rooms created this way with the supporting facilities of the bastion with the used of a postern preserved until today, for which the first known drawings of the bastion casemates were made by Charreton hired in Kostrzyn. It results from these drawings that the general layout of the rooms has not been changed significantly since then. The turn of the centuries would also be the date of placing a gunpowder storage in one of the cavalier rooms – its ventilation system is also a solution imported from France. Since 1701 there has been another reconstruction of the breastwork mentioned above to the French fashion, removing the access road for the guards. The bastion terrace was organised, introducing shooting ranges introduced to the breastwork, also allowing for firing above the breastwork. The famous 18<sup>th</sup> century presentations of the fortress in detail are partly contradictory, however, they seem to indicate that the fitting of the terrace and the location of the shooting ranges may have been changed several times. The aforementioned reconstructions did not include the cavalier breastworks which probably retained the original 16<sup>th</sup> century masonry breastworks (for the last time indicated in the inventory drawings dated 1833). In order to use the terrace of the building, it was being exposed from the beginning of roofing which could be disassembled: from two parallel pitched roofs set perpendicularly to its longer sides, through, along with the uniform gable and hipped roofs covering the whole area of the cavalier with the breastworks, known from the



inventory drawings of 1820, a hipped roof covering only a place | the area of he breastworks, to a fully covering hipped roofing functioning after 1945, with the use of the breastworks as a support for the lower truss beams. The point of the bastion included a gunpowder storage in the form of a light shed ('gunpowder tower'), which was removed at an unspecified date in the second half of the 17<sup>th</sup> century. Already at the beginning of the 18<sup>th</sup> century there was a gable roof building with an unknown function (equipment storage), which was removed subsequently. We are also unable to specify the point in which the characteristic watchtowers were removed from the corners of the bastion – it must have taken place already in the 1<sup>st</sup> half of the 18<sup>th</sup> century.

The last major works in Kostrzyn were designed already during he 7-year was, but there are no indications that the King Bastion was modified at that time. Besides, its conditions is documented by the inventory drawings from the period of the French occupation, consistent with the last review plan of the fortress from the late 18<sup>th</sup> century. They show that a part of the breastworks and the partition benches of the bastion was rebuilt again, especially the breastworks of its right flank. In the period of the fortress blockade in 1813/14, the French performed makeshift shelters on the terrace, in the form of mono-pitch roofing of planks covered with soil, based on the cavalier walls. Perhaps it was also in this period that the cross beam was implemented on the right front, visible in the inventory drawing of 1820. After the fortress were taken from the French, its organisation and expansion was initiated, and the state to which the bastion was brought is shown by its first precise inventory drawings of 1833. They show that the works were limited to the clean-up of its terrace, removal of unnecessary structures and an atrial built at the cavalier. Due to their scale, the subsequent review plans of the fortress do not allow us to determine whether any significant changes were introduced over the next few decades. During the clean-up of the fortification since 1814, also its moats were cleaned and the wooden formworks which previously protected the masonry slopes from washing out (with earth remaining at their base) were discarded, since they had to be supplemented and replaced periodically. They were replaced with softly falling earth slopes, initially locally reinforced with fascines.

More serious modernisation works at the fortress core took place after the line of the Eastern Railway was laid in 1857. The moat in front of the King Bastion was closed round 1860 with a coffer dam with a linked small tower on its outer edge. The design of the fittings in the lower tier of the cavalier of the war gunpowder storage comes from the year 1864, implemented subsequently in a slightly modified form. Also other rooms used for portioning of the gunpowder and elaboration were fitted at that time, reorganising the communication between the bastion flanks (the previous passages were walled and the new ones were arranged). It seems that the

shooting ranges of both flank batteries were rebuilt in parallel, however, it could have been earlier. A construction of numerous crossbeams was initiated in the 60s in the fortress, however, the plan of the designed works in case of arming the fortress in the years 1869-70 explains that none of them were erected on the terrace of the King Bastion. This probably ensued in the 70s when the core of the fortress was modernised intensively in connection with regarding Kostrzyn as one of the most important fortresses after the reunification of Germany, which were supposed to resist regular assault. The project of 1882, aiming at supplementing the cross beams, shows 7 cross beams on the bastion terrace, which were compliant with the technical norms of that period, including 4 with casemates – with shelters for the guards, if necessary, performing the depot functions for light cannons. Three further cross beams were located on the curtain, to the Berlin Gate (completely rebuilt from the year 1877), including one with casemates. In accordance with the applicable standards, the breastworks have been made thicker, cutting two shooting ranges in them at the bastion for light cannons flanking the moat of the Albrecht ravelin and the King – Brandenburg curtain. The project did not provide for any other changes in this area, and the later postcards and aerial photos confirm the recorded state of the bastion.

In 1886, the Kostrzyn fortress was de-classed, and the requirements concerning the oldest fortifications were limited – from that moment on, they were supposed to protect the core of the fortress at least from the surprise violent attack. Even in the first years of the 20<sup>th</sup> century, the King – Brandenburg curtain was removed. As it seems, until the formal abolition of the fortress in 1938, the layout of the bastion fittings did not change significantly. In 1945 a battery of small-caliber antiaircraft guns was located on its terrace. Apart from the concrete support in one of the rooms under the cavalier (generator?), no traces of adopting its premises as a shelter were found. At the end of March there was a direct hit with an aviation bomb of a relatively large caliber, which destroyed the left flank. In summer 1945, a symbolic necropolis of the Red Army was arranged on the terrace of the bastion, destroying the buildings located on it – the breastworks and traverses disappeared, whereas the level of the terrace was raised significantly in several places. A monument in the form of an obelisk was located on the point of the bastion. Tombstones were placed on a buried grid of lightly reinforced concrete. The curtain of the Berlin gate was transformed into a promenade, by erecting a monumental staircase on its north-eastern end. In the post-war period, the area of the cemetery was organised and renovated. Probably on the occasion of one of these projects, the walls of the cavalier were covered with a layer of bricks on cement mortar. In 1997, the basis for the left face of the bastion was reinforced with a concrete offset. In the years 2008-2009, the cemetery along with the statue was removed due to the

poor state of the facility.

## **5. Description of the Conducted Research** (Janusz Nekanda-Trepka, MSc Eng architect)

Architectural examinations have been performed on the basis of the following programme:

1. Analysis of the conservation inventory of the facility.
2. Examinations of the wall, offset, vault and opening connections.
3. Performing brick measurements in the building structures separated by the lack of connections.
4. Examination of the structures of walls and their technical stratification.
5. Surface examination of the façade structures.
6. Analysis of the stratigraphy of backfills with the drilling and pit methods, obtaining information on the spatial development of the Bastion and separating the soil structures to be implemented within the framework of the revitalisation works. One geological and archaeological borehole is expected within the undeveloped area of the bastion, between the faces adjacent to the cavalier.
7. Surface examination of damaged structures – ruined structures, for reconstruction purposes and in order to conduct protective works.
8. Comparative analyses with the historical material and indication of further research directions during the revitalisation works.
9. Developing conservation guidelines and conclusions for the programme of conservation works within the revitalisation of the King Bastion.

To examine the layers of the backfill and the possible insulation layers of the bastion casemates, an excavation was performed in the area of the blind ventilation opening on the axis of the vault on the area of 3m x 5m to the north east from the cavalier.

To examine the layers of the backfill in the undeveloped area, it was necessary to perform archaeological drilling before the casemates of the right shoulder, within a distance of 6.5m from the north-eastern façade of the cavalier;

the drilling was supplemented with probing which allowed for determining the embankment technology and the foundation conditions at the bedrock level. The description of the results is included in the geotechnical opinion concerning the King Bastion on plot No. 75/3 within the area of the former fortress in Kostrzyn nad Odrą, by Marek Ober, MSc, constituting a part of the project documentation.

The examination of the internal structures was implemented at the level of availability from the floor on vertical sections of the walls (below the resistance of the walls) by checking the binding of the walls, occurrence of plasters, assessment of the masonry thread types and measurements of bricks in selected areas of about 2m<sup>2</sup>, the places of measurement have been indicated in the drawing and the summary constitutes section 12.

4 pits of the floor have been performed, 3 at the level of 14m a.s.l. and one at the level of 18.50 in the cavalier, and 4 samples of the mortar were collected from the inner substance of the walls (at the points of damage).

For the studies of the wall structures, it was possible to use the existing robbery openings (probably made by treasure hunters) and damage allowing for taking samples of the mortars. The samples were subjected to laboratory tests, and the results are available in Appendix.

Due to the limited accessibility, and the size of the area, the examination of the façade structures was implemented through direct observation and analysis of photographs. The inaccessible areas of the vaults and the upper levels of the room walls were analysed in a similar way.

Due to the unavailability, the examination of the structure of the left shoulder structure were implemented through observation and photographic documentation.

## **5.1. Level -1 (18.50m a.s.l.)**

The examined level in the area of the cavalier includes an external entrance, stairs, two rooms and a ventilation corridor.

ROOM 1 – hallway with a bricked entrance to the terrace of the cavalier (post-war walling and rebuilding) at the level of the first step a hammered wall at ½ of the brick, modern, bricked in the 1980s. Stairs of brick with damaged steps (oak), with the thickness of about 5 cm on lime mortar (preserved lowest stair laid on the floor). Inaccessible structure of the stairs, probably empty space under the stairs – it is necessary to examine the structure and its technical condition during construction works. At the lower step, a walled original door opening to Room 2, and on the opposite side, the original door opening to Room 5, on the extension of Room 3. A

relief bow over the opening, with the thickness of 2 bricks, going from the floor level, and constituting the lintel of the door opening.

Photos: 1 to 5.

ROOM 2 – along the entire length of the cavalier: rectangular, vaulted, with the thickness of 2 bricks. The entrance to the room with an embrasure with preserved hinges of double doors. In addition, a walled, vaulted opening to the entrance corridor. From the western side, a wall tied with a homogeneous recess – tied corners, in the upper part of the recess a blind window opening (?) with hinges. Two openings in the vault, one forged and one as a result of masonry works as an original extension of the wall – probably a ventilation opening, currently unprotected. A large crack in the area of the opening from the east to the west – a stabilised, probably occurring as a result of an explosion in the left shoulder and the breach of the eastern part of the foundation of the casemates. In the western peak, a recess tied with the secondary untied closure, with an embrased blind opening. On longitudinal walls, at the height of about 2.3m, brick corbels with stone finishing, inserted secondarily every 2m (14 pieces on one wall) with a break in the area of the door, there were ceiling beams placed on the corbels – of the warehouse floor, probably with the area of 31 x 31cm, the so-called ceiling ones, typical for military structures of the 18<sup>th</sup> century. Walls originally plastered and whitewashed; the plasters implemented simultaneously with masonry works by scouring the squeezed mortar to the thickness of a few mm. The ceramic bricks were hand-made, the applied coarse lime and sand mortar. Gothic thread in the eastern part and the block thread from a half of the length. Only the heads are visible in the vault, which suggest the execution of buttresses; due to the lack of possibility to determine the number of the possible buttresses and their spacing. The floor of ceramic bricks laid flatly (about 7-9 cm) on the mortar and fine sand. Two measurement of the brick No. 1 and 2 were performed in the room, shown in the figure and included in the study.

Photos: 6 to 13.

ROOM 3 – the ventilation corridor with a vault, narrow and low, with hinges indicating the closure of the access from the hallway with the stairs; the walls and the ceiling plastered and whitewashed; stabilised cracks in the vault axis. An extension connected in the western top, with an inserted closure with air vents. A robbery pit on the eastern side at the distance of about 1.5m from the top (indicated in the inventory as Room 4) in the recess walled with a ventilation channel in Room



5. The pit shows the inside of the wall made of stones with the diameter of about 50cm, on coarse lime and sand mortar. Robbed floor (flatly laid bricks) on fine sand.

Photos: 14 to 18.

ROOM 5 – rectangular along the entire length of the cavalier, vaulted in the form of a cradle. The entrance to the room from the hallway of Room 1, with hinges for double doors from the inside. From the side of the room, an entirely visible relief bow. The eastern peak ties, in its upper part a shallow recess with a basket vault with hinges at the edges of the door frame, hidden behind a wall with a 'window' recess, also with hinges, sectionally vaulted and walled in depth (about 60 cm). A ventilation opening (?) over the vault basket of the larger recess to the ceiling. Both walls are longitudinal of hand-formed bricks on coarse lime and sand mortar, in Gothic thread in the eastern part and block thread in the western part. At the level of about 2.5m above the floor, both longitudinal walls have resistance openings for the beams of the wooden ceiling. In the northern wall, at the level of about 2m over the floor, there are three ventilation openings, embrasured and vaulted at an acute angle, with the height of about 1.8m, with a pillar wall visible in the opening, indicated in the inventory with a dotted line, inaccessible for direct examination. Under the extreme opening from the east, there is a recess of ½ brick, rectangular, with a door opening to the stairs with the wall thickness. This recess is cut with a crack opening to the ventilation opening located above and is also visible on the vault and the opposite wall. In the top of the western room, there is a transformed low and deep recess, walled with a chimney with a relief bow, as a location for a large ventilation channel with a diaphragm pillar indicated in the inventory with a dotted line. The northern wall of the recess was robbed by treasure hunters, but the lining of the recess and the side lining of the chimney pillar were preserved. The floor largely robbed of ceramic bricks laid flatly on fine sand. Two measurements of the brick were performed in the room, shown in the figure and included in the study.

Photos: 19 to 25.

ROOM 6 – stairs in the thickness of the north-eastern cavalier, leading to level –2 (14.0m a.s.l.). Stairs vaulted secondarily (rebuilt) at the entrance section, situated diagonally with a closing wall, with a window facing Room 19 with hammered window sill. The flight of stairs along the wall, topped with a sectional vault of ½ brick, brick steps of a roll based on the brick laid flatly, at the height of about 21 cm. The walls and the vault with the remains of whitewash, flat grouts. The lowest level

of stairs represents a quartered staircase and leads the stairs to the level of 14.0 a.s.l. to Room 17. This entrance is secondary, originally the stairs led directly to the door opening in the walled passage from Room 11 to Room 17.

Photos: 26 to 30.

## 5.2. Level – 2. (14.00m a.s.l.)

At the examined level there are 9 rooms in the outline of the cavalier and four in the right shoulder of the bastion. This level is also connected with the left shoulder of the bastion, which is inaccessible due to war damage and rubble.

ROOM 7 is a part of Room 10, separated secondarily with a brick diaphragm wall of machine brick, in the second half of the 19<sup>th</sup> century as a corridor with ventilation and lighting elements of Room 10 – 'ammunition laboratory.' The original wall of the primary layout is the western wall constituting the top of Room 10, performed of ceramic brick in the Gothic thread, on lime and sand mortar covered with whitewashed plaster with the thickness of a few millimetres. A measurement of the brick was performed in the room, shown in the figure and included in the study.

Photos: 31 to 34.

ROOM 8 – a postern connecting the casemates of the left shoulder with the cavalier, made as an arched vault, of manual ceramic brick in the Gothic thread, covered with whitewash – a room inaccessible for examination.

Photos: 35 to 36.

ROOM 9 – the corridor on the western side of the cavalier, constituting an extension of the entrance postern and leading to the casemates – the former part of the western front battery, adapted in the 19<sup>th</sup> century as an ammunition laboratory, vaulted in the semicircular form, at least to the thickness of one bricks (only the heads visible in the vault), supported on brick walls on lime and sand mortar in the Gothic thread. The walls covered with a thin layer of plaster and whitewashes damaged extensively along with the face of most bricks. The south-eastern top

(corner) walls with modern bricks with a forged irregular opening, in the north-eastern top, a passage to Room 11 lined with mechanical brick. Floor made of brick laid flatly on lime mortar. A measurement of the brick was performed in the room.

Photos 37 to 38.

ROOM 10 – rectangular, with a roll vault with the thickness of at least one brick laid in the north-western peak of the cavalier. The room is cut (shortened) with a slit brick wall of machine brick, with ventilation slots at the level of about ½ m over the floor and under the vault key, with an opening, closed with a window pane as the lighting of Room 10 'ammunition laboratory', separating the corridor of Room 7. The walls and the vault with traces of friction and the whitewash highly contaminated with carbon sediment, a gunpowder component, in the eastern corner, a walled original connection with Room 19, and a hammered opening at the northern corner (window – air vent?) to the area of the stairs – Room 6. On the floor of bricks laid flatly on sand there are concrete foundations for machines or devices, and there are openings in the walls suggesting supports for the technical equipment. In the top of the west entrance from Room 11, in the original opening lined with machine. A measurement of the brick was performed in the room.

Photos: 39 to 44.

ROOM 11, 12, 13, and 14 – rectangular, vaulted with a brick cradle, situated in a transverse way to the cavalier axis and on the extension of the right shoulder with casemates. The room was reconstructed in the 19<sup>th</sup> century by the insertion of a longitudinal wall with three entrances to separated small rooms No. 12, 13, and 14 which have entrances leading to Rooms 15 and 16, with the elements of ventilation and lighting of Rooms 15 and 16 ('gunpowder storage'), from Room 13 to Rooms 15 and 16. The passages and the openings are lined with machine-made hollow bricks, longitudinal walls at the room edges and the section of the traverse wall in Room 13 preserved in their original form of hand-formed bricks in Gothic thread, whitewashes covered with carbon powder. Vault with the thickness of at least 1 brick, with dirty whitewash. Floor of flatly-laid machine-made bricks. In the south-western top wall there is a robbery opening of about 60x60cm, with the total depth of 442 cm, showing the wall structure with a crack filled with loamy sand between the room wall and the additional wall of the cladding from the side of the river, the cladding has not been perforated completely. The room wall has the thickness of about 2m, is made of bricks differentiated in size, on a coarse lime and sand mortar (sample 1

and 2), and its inner face was walled in the Gothic thread, bricks that are transverse to the face are visible in the wall thickness (masonry typical for medieval walls). At the distance of about 2.5m from the western corner, the face is broken at the thickness of 6m, not tied with the eastern part. The north-eastern top wall includes a passage to Room 17, walled with machine-made bricks. The passage is tangential to the eastern wall, covered with a sectional bow exceeding the vault, which indicates its primary structure and building the vault; it is quite low in the arch, about 180cm. A measurement of the brick was performed in the room.

Photos: 45 to 59.

ROOM 15 – a rectangular room, vaulted with a brick cradle with the thickness of at least one brick, placed longitudinally in the area of the cavalier, walls under the vault resistance of hand-formed ceramic brick, on coarse lime and sand mortar in Gothic thread, the entire walls and vaults originally plastered by scouring the squeezed mortar and whitewashed. The floor of machine-made bricks 25.5 x 13.0 x 6.0cm, laid flatly on the floor made of halves of hand-formed bricks 14 (1/2 of 28) x 14 x 9cm, on lime and sand mortar. The lower floor is probably original, laid on the sand.

The western top wall is lined with machine-made bricks in the face of the former wall of hand-formed bricks, and apart from the entrance, it has a lighting window and an air vent. The southern wall is uniform over its entire length, is tied with the western top wall in which there is a robbery opening showing the inside of the wall of the thickness of about 180cm, perforated over its entire thickness; the soil in contact with the wall is a loamy sand, similar to the one located in the opening in Room 11. In the central part of the wall there is a ventilation core with two openings – one under the ceiling and two at the level of up to 1.0m over the floor. The chimney is built of machine-made bricks with worn corners, probably tangentially to the original recess (no traces of hammering). The northern transverse wall next to the top wall there is a passage to Room 16, sectionally covered, built along with the construction of the wall. The wall has two more openings of a similar nature, every 3.80cm, performed identically and elevated about 40 cm above the floor. Below the ceiling resistance, the wall is in Gothic thread. Two measurements of the brick were performed in the room.

Photos: 60 to 68.

ROOM 16 – a rectangular room, vaulted with a brick cradle with the thickness of at least one brick, placed longitudinally in the area of the cavalier, walls under the vault

resistance of hand-formed ceramic brick, on coarse lime and sand mortar in Gothic thread, the entire walls and vaults originally plastered by scouring the squeezed mortar and whitewashed. Partially robbed floor of machine-made bricks. The western top wall is lined with machine-made bricks in the face of the former wall of hand-formed bricks, and apart from the entrance, it has a lighting window and an air vent. The southern wall with three openings described in Room 15. The western top wall built identically as in Room 15, with a ventilation core of machine-made brick and air vents. Longitudinal north-eastern wall has three recesses to the ventilation ducts, the first one at the top wall was performed simultaneously with the wall and has a cradle vault and hammered wall (mortal sample No. 3) with a smaller opening to the ventilation 'chimney', built of hand-formed brick, without any traces of plastering. The recess is performed about 50 cm over the floor. The second recess is performed identically and leads to the ventilation opening with the rectangular section of 45x90 cm, which is wider at the top with the cavalier face, the duct was probably built later. In the punctured external wall of the 'chimney,' made of  $\frac{1}{2}$  of the brick there are visible soil layers in which sandy clay and sand are visible. The third recess is lined with machine-made brick and has a sloping floor. The inner wall of the recess has been punctured and backfilled with rubble, in which it is possible to see metal fortress doors. Between the second and the third recess there is a whitewashed bow in the area under the vault resistance to which the mortar goes without the traces later construction or walling. Identical two bows are located to the east from the third recess. The masonry method is not very clear, and due to the dirty whitewash, it suggests that these may be walled pillars of the foundation wall, built on point foundations tied with the bows and walled in the usable spaced along with their superstructure. The location of the extreme bow from the east in the area of the north-western wall of Room 17, excludes the possibility of opening them to the outside and suggests the occurrence of unfavourable foundation conditions of this wall part.

Photos: 69 to 78.

ROOM 17 – an irregular rectangle of the north-western battery with casemates. A multi-phase room built of ceramic brick on a rectangular plan secondarily vaulted with a brick cradle with the thickness of at least one brick, consisting of two layers with different radii. The southern layer is based on a wall built to the cavalier, on the terrace over the shooting stations, and the second layer is built at the previous one between the original north-eastern wall and the superstructure wall over the casemates. The ground floor is divided into rectangular rooms, extending to the south-western direction, with four shooting stations built later, divided with walls



perpendicular to the north-western wall of the front wall of the older bastion and vaulted cradles of 1 brick, on lime and sand mortar (sample 7). Two shooting stations from the side of the cavalier are covered with a terrace at the level of 3m over the floor; the third one is located in part under the terrace, and its northern part and the next shooting range with a superstructure wall. The shooting range faces has inbuilt shooting openings with a sectional and stair embrasure in the direction of the slope face. Shooting ranges are built in the face of the front slope. The shooting station under the transition of the terrace in the wall has an inserted reinforcement at the section of 2.0m from its face. The northern corner of the room has an entrance with stairs down to Room 18. The entrance is sectionally vaulted in the top wall of the room, adjacent to the sectionally vaulted shooting range. The shooting stations are performed simultaneously with the wall and the shooting openings, as well as the stepped embrasure. The terrace over the shooting ranges is covered with brick floor. The wall over the shooting stations is built at the cavalier wall. In the top constituting the cavalier wall, there is a vaulted passage to Room 11, walled with machine-made brick. In the passage jambs there is a walled opening at the extension of the stairs leading to level -1, and the entry to the stairs is located in a hammered and lined opening. In the eastern longitudinal wall from the northern side there are two cradle-vaulted passages to Room 19; then the wall is constant, built of hand-formed ceramic bricks with numerous sizes, on coarse lime and sand mortar. The floor of the room is made of ceramic bricks on lime mortar laid on the sand, and under it there is a stone pavement under the present level of the floor. Two measurements of the brick were performed in the room.

Photos: 79 to 91.

ROOM 18 – is a rectangular room sunken relative to Room 17 by 125 cm, with an entrance via brick fan-shaped staircase. It is covered with a vault with three ventilation openings leading to the outside – two to the north in the direction of the moat, and one to the south in the direction of the shooting ranges. The room is lined with a small-sized layer of brick laid flatly under the vault and plastered with a strong lime mortar with a strong tar-like carbon coating.

ROOM 19 – located perpendicularly to Room 17, rectangular, built of hand-formed ceramic brick with very differentiated dimensions laid in the Gothic thread, on coarse lime and sand mortar (samples No. 4, 5, 6), vaulted with a ceramic cradle with the thickness of one brick with buttresses in the northern part and a cradle with a varying thickness, covered with the crushed brick terrace – which was found in the.

The pit indicates that the southern part of the cradle was originally supported on a transverse wall constituting also the terrace sill. The vault has three performed ventilation openings, one at the cavalier wall and two at the edges of the lower cradle. All openings indicate that it was a secondary structure (little precision of brick connections). The top wall from the southern side is the northern façade of the cavalier with a vaulted window from the landing of the stairs and with the walled passage to Room 10, and opened passage at the eastern wall. The eastern wall is overlapping with the face of the eastern closure of Room 10 and the direction of the eastern façade of the cavalier. The wall is built of hand-formed ceramic brick, laid in the Gothic thread on coarse lime and sand mortar. Due to the partial backfill of the room and difficult accessibility, it was stated that the longitudinal walls indicate that they were built later at the cavalier and the top wall from the north, with the passage to room 20 was built at the Berlin Gate curtain and inserted along with the western wall, and in this part there are two vaulted connections with room 17. The western wall is built of hand-formed ceramic brick, laid in the Gothic thread on coarse lime and sand mortar. The floor is made of flatly laid bricks. Two measurements of the brick were performed in the room.

Photos: 92 to 97.

ROOM 20 – the north-eastern battery with casemates, built as a rectangular room, situated perpendicularly to the Berlin Gate curtain and thus traverse to Room 17 from which it is accessible. The room is rectangular, vaulted with a brick cradle with the thickness of 2 and ½ brick, with two ventilation openings in the vault arch, located at the top walls. The northern wall with two shooting ranges, at the same time the front of the shoulder, is built of ceramic brick in the block thread on lime mortar; the wall is fully built – not tied with the eastern curtain and the western wall – the top wall originally being the eastern façade of the left shoulder. The shooting ranges are rebuilt (inserted) with sectional lintels, opening to the north, with one offset, currently backfilled with loose bricks. The western wall is built of hand-formed face bricks in the Gothic thread, not tied to the longitudinal walls. The southern longitudinal wall was built at the wall of Room 17 and 19; it is made of ceramic brick in the block thread, on lime mortar, and in its eastern ending there is a transversely situated opening of the passage to room 19, vaulted with a tube of ceramic bricks, at the thickness of ½ brick. The eastern top wall with an offset of ½ brick within the distance of about 160 cm from the corner (as a line of the face of the southern wall) has a preserved, visible fragment of the lierne arch (recess), whose interior is filled with the passage tube corner. To the north of the vertical offset, the face of the western curtain is in the Gothic thread, of hand-formed bricks on lime and cement

mortar. No bond between the top and the external longitudinal wall.

Photos: 98 to 109.

**Rooms and remains of the left shoulder** have not been examined due to the lack of inventory and accessibility during the securing works. As results from the observations and the photos taken, the structure includes two levels. The lower level is situated at 14.00m a.s.l., currently completely filled with rubble. The upper level is differentiated, the postern entrance is at the level of 17.00m a.s.l. similarly to the floor of the extreme room from the west. The visible remains are mostly in the Gothic thread, however, the fragment of the orillon structure has a block thread; it is probably a lining performed at the thickness of almost 2 bricks. The dace is treated in a special way through the application of over-burned bricks. With the lack of remains measurement, the attempt at the reconstruction on the basis of the inventory of 1833 is virtually impossible and only includes suggestions of divisions.

Photos: No. 110 to 115.

### 5.3. Earth Structures and Buttresses of the Bastion and the Cavalier Façades

On the basis of the archaeological and geological examination, as well as architectural observations, it is necessary to consider that there are 3 phases of backfill modifications in the soil layers.

The first phase of the fortress construction in the middle of the 16<sup>th</sup> century is visible at the level of 9.32m a.s.l. as a construction phase on a stable clay and sand substrate. The buildings are then covered with sand and humus, with a usable layer at the level of 14.42m a.s.l., which is the starting point of the construction layer of the second phase which included the elevation and extension of the bastion. Subsequent backfilling stages are visible at this point, to the level of 18.72m a.s.l. Other intermediate phases are not visible in the drilling.

The last phase are the 'cleaning by the Red Army' after 1945, the demolition of the earth elements and the elements down to the level of 18.72m a.s.l., as well as flat levelling of the square at the curtain level of about 21.00m a.s.l.

In the performed pit over the vault of the right shoulder, it was determined that it

was filled with soil and rubble from the period after 1945. There are no waterproofing insulation, the lierne is covered only with mortar, and the backfill thickness does not protect the upper vault layers from freezing.

The Berlin Gate curtains from the side of the river are rebuilt with numerous losses, and from the side of the town they consist of a part being in contact with the Berlin Gate, implemented with hand-formed ceramic bricks in the Gothic thread on lime and sand mortar. The central part includes two vaulted rooms, opened in the direction of the town – destroyed. Then the retaining wall is erected in the block thread in the 19<sup>th</sup> century, which is then transformed into a concrete wall, maintaining the paved way to the bastion terrace.

Photos 117 to 123.

Façades of the bastion front claddings constitute a very large area which is hard to reach, and their faces were repaired many times, also with cladding. The oldest parts of the façade were performed of ceramic face brick on lime mortar in the Gothic thread; linings and claddings were also performed in the block and the fortress style; during certain works, a rough case of cement and lime or cement was applied. The western part of the bastion front cladding from the side of the river has been supported with a concrete base.

Photos 124 to 139.

The cavalier façades were clad when the war cemetery was being arranged, with modern, machine-made bricks. The cladding from the southern, eastern and western side was performed at the thickness of ½ brick on cement mortar. The cladding from the western side is also the walling of the ventilation elements and is performed in stripes of ½ and ¼ of a brick, also on cement mortar, constituting a 'composed' wall.

Photos 140 to 143.

## 6. Conclusions

The King Bastion is a multi-phase fortification built on a stable substrate elevated over the level of the river whose waters were probably at a lower level at the time of building the fortifications than they are now (silting of the riverbed). The

analysis of the links and construction elements such as stairs in the thickness of the wall and cladding of the wall of the left face of the south-western side of the cavalier indicate that the cavalier with a casemates storey at the level of 14m a.s.l. was initially exposed and covered with shooting positions. Building the terrace walls at the right flank to the north-eastern façade of the cavalier, constructed as an exposed façade with a lighting window for the stairs and a wide passage from the cavalier to the shoulder terrace, indicates that the terrace was built with the shooting stations almost simultaneously with the creation of the one-storey cavalier. The shoulder terrace covered with the orillon was inserted in the shooting ranges on the north-western and north-eastern direction, which indicates that the initially one-storey cavalier constituted the main artillery terrace reinforced with the battery of the left flank, also covered by the orillon, defending the curtain between the King and the Brandenburg Bastions. Such positioning of the artillery terrace excludes the possibility of simultaneous existence of the fragment of the north-western part of the cavalier and the transverse casemates (Room 11); it was a front casemate and it could have artillery shooting stations in the north-western direction, and its north-western wall could have cladding along the line consistent with the slope of the existing, currently walled shooting stations of the right flank.

In addition to the aforementioned considerations, the existence of a one-storey structure is indicated by the lack of connections of the room structures of level 18.5m a.s.l. with the structure of rooms at the level of 14.0m a.s.l. The walls of level -1 are conflicting with the walls of level -2 in the south-eastern part which is visible in the performance of the relief bow in the wall between the central corridor and Room 5 in the area of the entrance, whereas the following elements show compatibility in the north-western part: ventilation corridor situated over a wide wall between gunpowder storages and the external walls of the rooms are situated on the walls of the lower level. Such a location of the wall structures results in the simultaneity of construction of the north-western part of the cavalier at both storeys. The analysis results in the fact that the remains of the first construction phase of the cavalier at level -1 is a withdrawn wall with an entrance to the stairs and the stairs itself with a window in the north-eastern direction to the area of the shoulder terrace. The application of very diversified bricks coming from different production plant of this material is characteristic for the lower parts of the shoulder terrace structure, which resulted from the supply of materials from different parts of Neumark. The brick measurements indicate a large discrepancy of the sizes in relation to the measurements at level -1, which are almost uniform. The existence of a postern leading from the cavalier to the shoulder terrace of the left flank in the original outline of the cavalier indicates the simultaneous existence of this terrace and the 'small' cavalier. Provision of the lateral walls of the left flank to the curtain of the western fortress and to the orillon wall visible in the remains of the destroyed



shoulder, indicates the existence of a symmetrical structure of both flanks of the 'small' bastion.

The extension of the bastion was based on expanding the bastion terrace to the north, elevating its usable level to about 23.00m a.s.l. in the point; it was connected with the extension of the cavalier in the north-western direction, closure and superstructure of the front batteries of the terrace, introduction of the second level and the elevation of the left-flank walls, as well as a new cladding of the left and right face of the bastion with the construction of new orillons, while maintaining the level of the right flank courtyard and the performance of the new courtyard of the left shoulder and adding casemates to the flank battery.

As results from the research, the sand from the river was used for all earthworks and mortars, delivered in the water under the fortress itself.

Posterns were built probably to connect the courtyards with the town. In the right flank (visible entrance with the bow at the corner of Room 20), the postern could have been used before adding the casemates to the whole shoulder terrace, and then closed. The bow in the corner of the left shoulder which was regarded by K. Biskup as a staircase is probably the original postern to the older shoulder terrace, which was conflicting after adding the casemates to the shoulder battery and therefore the new one was performed already at the level of the elevated flank terrace and still exists today.

Damming the left shoulder and its partial coverage with a vault and the vaulting of a part of the terrace of the right shoulder is definitely secondary and inserted in the earlier structures of the curtain buttress and orillons, which was implemented in two stages. At the beginning, the part tangent to the cavalier was vaulted with the vault support on the wall that no longer exists, closing the courtyard in the middle, and then a vault was performed on the section between the shooting range wall and the non-existent terrace wall, and this wall was disassembled, creating the present one-space casemates. At the same time, works were conducted in two phases to vault the orillon terrace with closed shooting ranges. Another stage was to close the shoulder courtyard to the moat line and its vaulting.

The inside of the cavalier includes the expansions and superstructure of the ventilation system in the north-eastern top, connected with the construction of the war gunpowder storage. Probably the storage function at level -1 caused the insertion of corbels and making the openings for the beams of the intermediate ceilings and the performance of openings in the south-eastern top. Another activity is the 19<sup>th</sup> century reconstruction of the gunpowder storage at level -2, and the change in the spatial system by the construction of a corridor and shortening the

south-eastern casemates. The construction of a 'modern' war gunpowder storage with an ammunition laboratory forced also the walling of the passages and performing staircases, atria and lighting room for the gunpowder storage rooms, where the application of a machine-made hollow brick and the characteristic 'patina' of the coal dust is indicative of the occurrence date.

The recent history has left very clear traces in the form of the destruction of the left flank of the bastion and the remains of the Red Army cemetery built after 1945.

At the current stage, it is impossible to describe the operation of the ventilation system of the bastion and the casemates, as well as the terrace drainage system and the moisture protection of the walls and the vaults; only the earthworks will enable the exposure of the external parts of the construction structures, including the ventilation constructed to the outer side of the building.

During the revaluation works and the exposure of a part of the buttress, it is necessary to continue the examination and to confirm the aforementioned conclusions, as well as complement the results of examinations of the currently inaccessible left shoulder.

On the basis of the conducted examinations, it is possible to indicate the directions of revaluation and use of the bastion structure as an exhibit of the Kostrzyn Fortress Museum. The external exhibition of the bastion requires an aesthetic unification of both the structural and ground parts. Apart from the cubature reconstruction of the left flank of the bastion, it is necessary to reconstruct the façades and the superstructure of the cavalier, as well as the earthworks of the terrace and the Berlin Gate curtain. It is necessary to consider the possibility of exhibition of the curtains with continuous light placed in the reconstructed crowning cornice of the fronts and façades of the cavalier.

No exhibits vulnerable to weather conditions should be placed in the interiors of the casemates, and it would be favourable to limit to the exposure of the building itself. One of the proposals is to preserve and complement fragments of the whitewash in the inside of the cavalier and to leave the casemates of the left shoulder in the face brick, with the emphasis on the visible parts of the façade, which used to be exposed. It is also necessary to reconstruct the losses in the walls, created as a result of post-war robbery activity of treasure hunters and thieves of metal elements (removed steel doors). It is necessary to restore ceramic and brick floors at level -2.

It is recommended to apply discrete lighting, consistent with the climate, with the use of industrial luminaires. All the installations should be routed in the floors, as

well as on the surfaces of walls and vaults, without covering and placing them in the forged structure. Preserving and exhibiting the “war gunpowder storage”, it is necessary not only to preserve the usage patina, but also to make their usage indicative, e.g. by reproducing the lighting and ventilation system.

The limited reconstruction of the left shoulder of the bastion allows for the implementation of full service for the visitors and the introduction of modern information elements in its partially preserved interiors.

## 7. Stratigraphy

On the basis of the historical and architectonic research, it is possible to indicate eight construction phases of the King Bastion.

The first phase, without taking into consideration the medieval defence systems, is connected with the construction of the fortress after 1537 and includes the construction of a bastille with the dimensions of about 22 x 18m, at the level of 9.32m a.s.l. (a construction layer in the geological and archaeological borehole), with an embankment elevated to the ordinate of 14.42m a.s.l., on which a further construction layer was found. This bastille is raised 4m above the slopes of the soil embankment, and had an artillery terrace at the level of 18.50m a.s.l. The remains of this fortification work is a part of the lower tier of the cavalier with the following rooms: 6, 7, 9, 10 and 11, extended by the thickness of the external walls. In the middle of the 16<sup>th</sup> century, this bastille was equipped with a terrace at the level of the today's level –1, to which there was a staircase in the wall thickness, but it could also have a traverse of the embankments surrounding the town.

The second phase was the creation of the bastion with the front part from the north-western side, in contact with its north-eastern façade, which included a preserved series of four horizontal shooting ranges and a gunpowder storage in the orillon and a shoulder terrace. The lower parts of rooms 17, 18, and 19 were preserved from this phase. The left shoulder and the orillon were probably added simultaneously, and the remains of the orillon may be the part of the south-western wall of the left flank. It must be assumed that the natural conditions connected with the riverbed significantly hindered the construction of durable fortifications and therefore, the defence structures and their new shapes overlap in the successive phases.

The third phase is connected with the extension of the bastion in the years 1587-1588, when the outline of the bastion was changed by its elongation and thus extension to achieve a permanent shape of its substantial part until today. During this expansion and the elevation of the terrace level (the trace of this expansion is

visible in the layers of the backfill in the form of a construction layer at the level of 14.42m a.s.l.), the works included the expansion and elevation of the cavalier, the terrace of which was then located at the level of 24.50m a.s.l., i.e. also about 4m above the bastion terrace. The cavalier was also expanded horizontally, by adding 18m of the casemates at both levels.

Another phase – the fourth one, is connected with the construction of the second artillery level and the right flank which probably occurred in the first half of the 17<sup>th</sup> century, and its remains should be visible in the ruins of the left flank and under the floor of Room 19.

The fifth phase is limited to the fitting of the casemates in the lower part of the cavalier level with a system which allowed to arrange them as gunpowder storages, and was implemented at the beginning of the 18<sup>th</sup> century.

The sixth phase included changes in both flanks, based on constructing new vaults of the courtyards and adding casemates to them, as well as increasing the number of shooting ranges, which is indicated in the plan of the fortress prepared by Abraham von Hubert, dated 1750. The postern of the left flank was built within this stage. The remains of this phase are the vaults and the structure of the open shoulders, including the construction of the casemates now constituting Room 20.

The seventh phase also concerns the changes at level –2, based on shortening the casemates in the south-eastern part of the cavalier and the construction of a corridor with an entrance to Room 19, and closing the passages to Rooms 10 and 11, performing a staircase in the wall and making an entrance directly to Room 17. This phase included the performance of partition walls and a new ventilation with the use of the space over the vault, along with the connection of lighting windows of the gunpowder storage and the ammunition laboratory. These works were performed after the year 1864.

After the abolishment of the fortress in 1938, the bastion rooms were adopted as a shelter, but without significant modifications. In the last days of World War II, the rooms of the left flank were destroyed as a result of a missile or bomb explosion. After the war, the area of the terrace was transformed into a necropolis of the Red Army soldiers. The area levelling and the buttress of the cavalier constitute the last eighth phase of the bastion formation before it was entered in the register of monuments.

## 8. Guidelines for Further Research

In the course of the construction and conservation works, with the participation of construction teams, and after securing the construction site, it is necessary to

conduct opencast examination at the front yard of the bastion, cavalier terrace and the interiors of the fortress structures in order to verify the conclusions from the surface examinations. It is necessary to perform excavation examination of the front of the closed battery of the right flank and its contact with the walls of the cavalier implemented with the excavation and repair of ventilation ducts built at the north-eastern walls of the cavalier. Examination of the front of the lower cavalier part in the area of the postern leading to the left flank, with the simultaneous examination of the resistance walls of the casemates of the left shoulder from the side of the cavalier and the repair of its crown along with the vertical insulation which should be made of loamy sand, which is indicated by the robbery openings in the lower and the upper part of the cavalier. Excavation examinations of the Berlin Gate curtain in the area of the alleged postern at the contact of the curtain face with the structure of the right shoulder, and its possible reconstruction and opening. In the course of the removal of the levelling layer after 1945, it is advisable to examine the finial of the front walls and their buttress structures. During the removal of the embankment on the cavalier terrace, it is necessary to examine and repair the façade finials, remove rubble from the stairs and repair the vault of level –1 before a new terrace is built. Before the reconstruction of the floors at level –1, it is necessary to conduct excavation examinations of level –2, mainly in the area of Rooms 10 and 11, which have numerous ventilation inlets whose vertical and horizontal routes are unknown and which should be repaired and unblocked. Similarly, it is advisable to perform excavation examinations of the location of lateral walls in Rooms 17 and 19, as well as make a decision on the possible return to the level of the discovered stone pavement. It is required to examine the front façades of the bastion which require the setting of scaffoldings and a significant replacement of the brick face; the examinations should show the uniformity or cladding of the buttress and undertaking appropriate remedial actions.

## **9. Conservation Guidelines and Conservation Works Programme Proposal**

The values of the King Bastion include an original multi-phase earth structure with traverses and cubature structure: of the cavalier, right shoulder, remains of the left shoulder and retaining walls, as well as the buttress of the curtains to the added level of their finial. The value here is the historical information (scientific value) as well as the educational and cultural value (the cultural landscape of the fortress city). Attempts are made to protect the original structures created in 1945, as well as the dimensions and the historical appearance lost as a result of warfare and brutal post-war interference. To restore the proper landscape of the fortress, it is necessary to reconstruct the original dimensions of the bastion, including the cubature outline of the left shoulder and the system of ground fortification works



within the whole bastion and the curtain of the Berlin Gate, as well as the brick breastworks of the cavalier. It is permitted to perform a reconstruction of the cavalier roofing in the form known from the archival documentation.

9.1. Demolition works: First of all, expose and remove rubble from the ventilation shafts, clear and protect against precipitations. Remove shrubs and trees growing in the traps and the cavalier, as well as to remove rubble from the entrance to the cavalier. Disassemble the railings located along the bastion curtains and the Berlin Gate.

It is necessary to disassemble the walls and the claddings to clear the ventilation openings of the cavalier. Disassemble the wall finials and pavements performed after 1945 and remove rubble from the buried casemates of the left shoulder under the conservator's supervision. Uncovering the protected vault in Room 20 of the right shoulder. Disassemble the wall finials being in a threatening state. It is necessary to remove the embankment of soil and rubble to the historical level of the sand embankment. Perform the open pits of the historical walls indicated in section 6 and examine them.

9.2. Masonry and restoration works: Perform repairs and reinforcements indicated in the technical assessment, including the vault reconstruction in room 20 of the right shoulder and reconstruct the stairs to the cavalier and perform the terrace in accordance with the same documentation. Implement the restoration project of the left shoulder to the level of its highest ceiling and this project should include a reconstruction of the spatial system of level – 2 and a cubature superstructure of level –1 along its historical outer circumference, retaining single space of the north-western part and performing vertical communication there (stairs and elevator). It is allowed to resign from the reconstruction of the divisions at level –1, except for the reconstruction of the curtain walls and shooting ranges. It is recommended to locate in the new space the sanitary rooms for the personnel and the visitors, as well as a control station for lighting, signalisation, and monitoring, with the necessary technical facilities.

9.3. Finishing works:

9.3.1. On the basis of the conservation assessment, perform the necessary renovation works on the surface of the walls and vaults, retaining the



original plastering remains within the area of the cavalier, and retaining the area of the right shoulder in face brick, with the emphasis on the face of the original curtain façade. The dirt in the gunpowder storage rooms and the gunpowder laboratory (ROOM 7, 10, 12, 13, 14, 15, and 16) constitutes the 'patina resulting from use', which is to be maintained and preserved.

9.3.2. It is necessary to restore ceramic floors within the area of the cavalier with the recommended restoration of their original levels and materials in places where it is possible and justified in terms of use. In view of the state of the walls and vaults, it is allowed to locate the necessary installations and supporting elements under and on the floor. The existing entrance stairs should be covered with oak stair steps after the repair, in accordance with one preserved step.

Complete and wall up 'robbery pits' and preserve the elements of metal hinges, handles the only preserved division anchor and fortress door which can be exhibited on site.

9.3.3. The faces of the front and shoulder buttresses should undergo maintenance and repairs indicated in the conservation documentation. The concrete pedestal of the western curtain should be preserved and covered with an overhead of pebbles (diameter approximately 10--15 cm), while keeping the dimensions of the road under the curtain, the road edge should be reinforced with pins and fascine.

#### 9.4. Earthworks on the bastion terrace and the Berlin Gate curtain:

On the identified original layer of the sand embankment, after its compaction, it is necessary to perform the necessary insulation coatings which do not block the evaporation of moisture from the lower parts of the backfill and drainage of the areas without the natural discharge of rainwater. The shape of the terrain and the layout of the breastworks and traverses should be performed in accordance with the reconstruction prepared by the Kostrzyn Fortress Museum. It is allowed to perform an extension of the access road (traverse) with paving stones – cobblestones or lose halved stones, without curbs, as paths for massive tourism, with the necessary protection and lighting with low garden lamps (up to 50cm) and the proposed exhibition lighting of the cavalier and curtain gates. The site development should be performed in a uniform way throughout the whole outline of the bastion and the Berlin Gate curtain.

#### 9.5. Installation works

9.5.1. Lighting: At level –1 (18.5m a.s.l.) on the stairs and in the ventilation corridor, cast iron fittings tightly connected to the wiring suspended to the ceiling. In room 2

and 5, the cast iron fittings tightly attached to the longitudinal walls at the level of 2.5m over the floor, on both sides, with wiring attached to the walls. At level –2 (14m a.s.l.) the cast iron fittings are tight in the corridors and rooms 10, 11, 15, and 16 on cables suspended to the ceiling. In room 10 and 13, exhibition lighting with wiring placed on the floor. Rooms 12 and 14 without lighting. In rooms 17, 19, and 20, the exhibition lighting is attached on supports fixed to the floor and powered with the wiring laid in the floor. In room 18, a tight cast iron fitting on the entrance wall under the ceiling, powered with a cable routed in the floor and locates in the entrance wall.

Lighting fixtures should be equipped with emergency power supply with a visible direction of evacuation.

Guidelines for the lighting do not apply to thee reconstructed part of the left shoulder and the sanitary rooms for the personnel and the visitors.

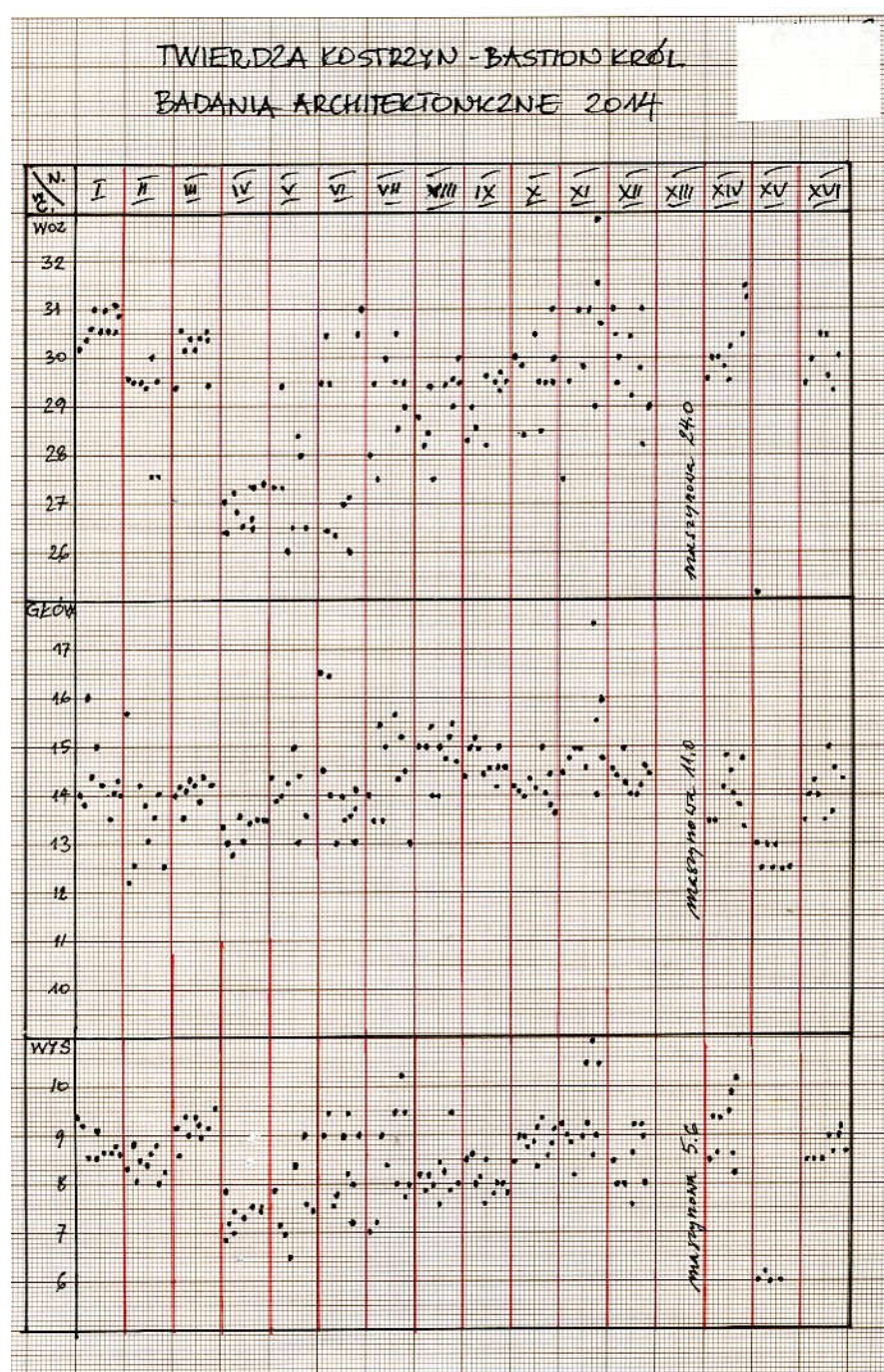
9.5.2. Ventilation: After performing the external pits, the historical installations ensuring the flow and suction of air, after checking the natural air flow, it is necessary to perform controlled shutters and baffles to achieve 1.5 times more extensive air exchange during the use of the premises 1 time more extensive air exchange when the premises are closed for the visitors. The heating of the rooms and tight closure of openings other than the external entrances and safety barriers is not provided for.

Not applicable to the reconstructed parts of the left shoulder and the sanitary facilities for the personnel and the visitors.

9.5.3. Drainage: No plumbing installation is provided in the closed rooms. Not applicable to the reconstructed parts of the left shoulder and the sanitary facilities for the personnel and the visitors.

**Any changes to the guidelines require the approval of the Lubuskie Region Monuments Conservator, Branch in Gorzów Wlkp.**

## 12. Summary of the Brick Measurements.



## 13. Photos Illustrating the Research Descriptions



<b>INVESTMENT</b>		
<b>NAME: REVITALISATION OF THE KRÓL BASTION – A PART OF THE KOSTRZYN FORTRESS – FOR CULTURAL PURPOSES</b>		
<b>ADDRESS:</b>	<b>Bastion Król, Zespół Fortyfikacji Twierdzy Kostrzyn, plot No. 75/3, K. nad Odrą</b>	
<b>INVESTOR:</b>	<b>City Kostrzyn nad Odrą, Ul. Graniczna 2 66-470 Kostrzyn nad Odrą</b>	
<b>PHASE:</b>	<b>TECHNICAL CONDITION ASSESSMENT OF THE KRÓL BASTION</b>	
<b>SECTOR:</b>	<b>CONSTRUCTION</b>	
<b>DESIGNED BY:</b>	Bartosz Januszewski, MSc Eng  Construction licence No. ZAP/0102/POOK/08  Specialty: construction	

Documentation prepared for the project 'FORTE CULTURA Capitalizing of fortified cultural heritage for sustainable development and competitiveness of cities and regions' implemented through the CENTRAL EUROPE Programme co-financed by the ERDF.

Lead partner of the Forte Cultura project:

Town Hall Kostrzyn nad Odrą

ul. Graniczna 2

66-470 Kostrzyn nad Odrą

+48 95 727 81 24

+48 95 727 81 93

Email: [fortecultura@wp.pl](mailto:fortecultura@wp.pl)

<http://www.forte-cultura-project.eu/>

SZCZECIN, OCTOBER 2013

**ALL RIGHTS RESERVED**

## I . CONTENTS OF THE STUDY

I . CONTENTS OF THE STUDY.....	
I. TECHNICAL CONDITION ASSESSMENT .....	
1. GENERAL DATA .....	
1. BASIS FOR THE STUDY .....	
2. SUBJECT MATTER AND SCOPE OF THE STUDY .....	
3. DESCRIPTION OF CONSTRUCTION SOLUTIONS .....	
4. ANALYSIS AND RECOMMENDATIONS .....	
5. OVERALL ASSESSMENT OF THE TECHNICAL CONDITION OF THE CASEMATES.....	

## I. TECHNICAL CONDITION ASSESSMENT

### 1. General Data

- 1.1 Investor : City Kostrzyn nad Odrą  
Ul. Graniczna 2  
66-470 Kostrzyn nad Odrą
- 1.2 Project : Revitalisation of the Król Bastion – a Part of the Kostrzyn Fortress – for Cultural Purposes
- 1.3 Facility : The Król Bastion
- 1.4 Sector : Construction
- 1.5 Phase : Technical condition assessment
- 1.6 Location : plot No. 75/3 owned by the Municipality of Kostrzyn nad Odrą

### 1. Basis for the Study

- 2.1 Order from the architectural sector.
- 2.2 Site inspection with detailed visual inspection, stocktaking, and own measurements.
- 2.3 Photographic documentation.
- 2.4 Documentation of research works 'Survey on the Terrace of the Król Bastion' of 21-22 January 2014.

### 2. Subject Matter and Scope of the Study

The subject matter of the technical condition assessment shall be the structural elements of the Król Bastion, a group of modern age fortifications from the 16<sup>th</sup> to 19<sup>th</sup> century. The facility is located within the area of the Old Town in Kostrzyn nad Odrą, on its south-eastern edge, along the Oder River and preserved sections of the moat. The objective of the assessment is to show the technical condition of the



facility in order to implement a construction project including the reconstruction of the south-western barge of the Król Bastion, restoration of earthen fortifications, the cavalier, and the renovation of the casemates. It is also connected with the renovation of the façade walls and their partial reconstruction. The repairs will also include the ceiling part of the casemates as well as the cavalier.

### 3. Description of Construction Solutions

#### 4.1 Characteristics of the facility.

The discussed facility constituting a part of the fortifications from the 16<sup>th</sup> to 19<sup>th</sup> century is located within the area of the old town in Kostrzyn nad Odrą, on its south-eastern edge, long the Oder River and the preserved sections of the moat. The whole area of the Old Town is covered with a conservator protection and archaeological observation zone. The fortification of the Kostrzyn Fortress are entered in the register of monuments under No. KOK-I-81/76 of November 1976.

The Król Bastion was built during the first phase of the fortress extension in 1568, and constitutes one of the oldest fortress elements. In the years of its operation, it was one of the strongest elements of the fortress. During World War II, the Król Bastion was destroyed and became the site of the mausoleum for Soviet soldiers killed in the fights in 1945.

The property consisted of a barge and a three-storey complex of underground casemates. Moreover, a characteristic element of the bastion is the so-called Small Cavalier, hiding the entrance to the extensive underground part. The upper part of the cavalier includes three strings of casemates. The extreme naves have two storeys and are divided with a wooden ceiling based on brick supports. From the level of the northern casemates located in the area of the cavalier, there is a winder staircase leading to the lower system of casemates. The layout of the casemates inside the bastion formerly served as battle stations, shelters, and warehouses. The ventilation system visible in the cavalier room indicates a war gunpowder storage from the turn of the 17<sup>th</sup> and 18<sup>th</sup> century. The casemates form

one of the most interesting design solutions concerning fortress interiors. The wall crowns and the bastion ceilings are overgrown with self-seeding trees and shrubs. The wall includes visible repairs of defects, incompatible with the art of conservation with randomly selected demolition materials, and without the proper selection of mortars. The sequence of the walls within the old mausoleum for the Soviet soldiers constituted a walking and observation string, which was excluded from use due to the condition of the vaults in the casemates.

In the immediate vicinity of the bastion there are ruins of the quarters of the Old Town buildings, as well as facilities characteristic for the Old Town of Kostrzyn.

#### 4.2 Subsoil.

According to the geotechnical documentation, it was possible to determine the existence of anthropogenic soils which have probably been consolidated under their own weight. These are embankments in an averagely compacted state, with the average degree of density  $I_d=0.45-0.5$ . Due to the lack of the possibility to implement drilling in the central part of the barge, the drilling was performed as close as possible to the existing wall, outside the outline of the facility. The soil tests are approximate tests which are aimed at determining the type of the residual embankment. Prior to the construction works, it is necessary to perform pits of the permanent ruins, and the proposed corrective solutions should be verified with the designer.

#### 4.3 Structure of the facility and its condition.

A facility of quadrilateral shape with two faces crossed at an acute angle, as well as short barges with an entrance to the system of casemates.

### **External curtain walls from the side of the Oder River**

The walls above the existing terrain from the side of the Oder River were built of bricks, on lime mortar, with a neat and uniform bond. The curtain walls at the site of contact with the soil is protected against direct impact of the river water, a band of reinforced concrete offset by about 40cm, the depth of the foundation has not been specified. The top layer of bricks (the face of the wall) with strongly corroded brick.

In places where the wall is covered with cement plaster with greater resistance than the original material, there are numerous scaling spots, causing the brick corrosion and grout loss. The corrosion of the wall face is so strong that the bricks crumble when touched. Some of the cracks visible in the walls were caused by warfare operations. In several places the walls have been repaired with the use of a material incompatible with the original material. The process causing the acceleration of the wall corrosion is also the locally overgrown vegetation. The wall crown has been rebuilt and covered with a reinforced concrete ring to which the railing is attached. Despite numerous defects of the bricks and the mortar as well as local cracks in the face layer of the walls, the overall technical condition of the walls is defined as good. Most of the visible damage, including local cracks, are not dangerous for the stability and the future existence of the structure. The causes of many of the aforementioned defects are caused by long-term weather impact along with insufficient protection of the facility and wrong choice of protective materials. The basements of the bastion and the curtain walls are exposed to the direct impact of the water from the Oder River and the moat.

Photo 1,2 Top layer of bricks (the face of the wall), covered with cement plaster with clear corrosion of bricks





Photo 3 View of biological corrosion of the wall bricks in the area of the moat

Photo 4 View of the reinforced concrete band, partially offset by about 40cm



## **Walls of the left barge (southern)**

As a result of military operations at the end of World War II, both the structure of arched vaults covering the barge, as well as the curtain walls were completely destroyed. Only single pieces of vaults and load-bearing walls were preserved. On the basis of the conducted visual assessment of the facility, based on an examination of its geometry, slenderness, type of cracks and the places of their occurrence, it can be concluded that the elements of the structure remains of the barge are in neutral balance. Poor fixation of the remains of wall elements indicates the possibility of further damage which may be of local character, not jeopardising the stability of the structure. During the conducted repair works, in October 2013, all the vegetation and the earth embankments were removed within the area of the south-western barge. After removing layers of earth and rubble, fragments of arched vaults were discovered at the level of the existing ground, which indicated the presence of an additional floor connecting level -2 of the cavalier casemates.

Due to the poor technical condition, and the threat of collapse of the vault remains at the front wall of the barge, the vault was demolished and constructed again, maintaining the original shape. Crowns of the walls were reconstruct with the use of solid brick recovered during the pit works. The works were performed in order to maintain the condition of the existing facility, before it is possible to carry out conservation operations.

Photo 5 View of the southern barge from the level of cavalier terrace

Photo 6 View of the southern barge from the level of the existing embankment



Photo 7 View of the wall remains of the southern barge

Photo 8 View of a fragment of the curtain wall remains





Photo 9 View of the repaired vault at the front wall of the barge from the inside

Photo 10 View of the repaired vault at the front wall of the barge from the outside



## Casemates at level -1

Both the walls and the arched vaults of the casemates were erected as made of solid bricks on lime mortar. The ceiling layer system consists of brick barrel vaults with a ground embankment with the thickness of about 60 cm. The thickness of the vault support layer over the cavalier is determined as uniform, in the form of two bricks laid vertically. The thickness of the vaults can be indicated by the areas of ventilation stacks where it is possible to see a clear arrangement of bricks. In a part of the corridor (-1.03), the walls are partially plastered with multiple defects. Thickness of the walls separating the corridor from the casemates: 60cm. Brick floor with visible traces of condensed water. Due to the absence of horizontal insulation of the cavalier vaults and the lack of proper precipitation water drainage, the vaults and walls have traces of moisture. There are cracks on the walls which were probably caused by military operations. Having obtained information from persons who analyse the facility for several years, it was possible to determine that the existing cracks do not expand in size. The stability of the structure shows that these wall parts are in a state of stable balance and do not constitute a threat to the stability of the structure, even without the necessity to undertake safety works in the near future.



Photo 11 View of the vault of the casemates in the area of ventilation openings

Photo 12 View of the cracked wall in the area of the arc reinforcing the wall of the casemates

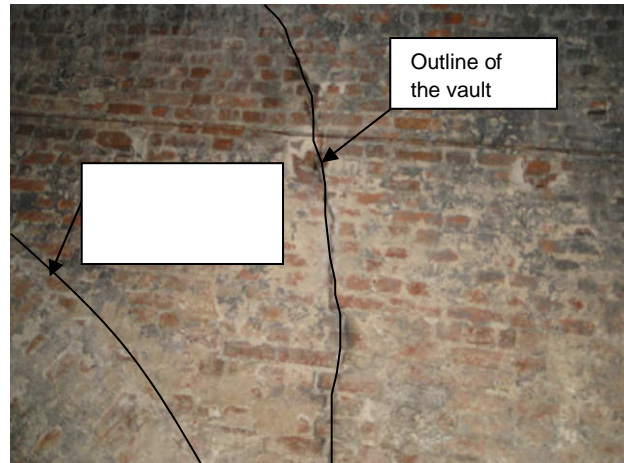


Photo 13 View of the vault lined with plaster

Photo 14 View of the floor with traces of condensate water



## Casemates at level -2 (cavalier)

The system of ceilings, similarly to the cavalier of level -1, is a single-layer barrel vault, supported on masonry walls. In all rooms the walls and arched vaults are covered with diluted tar. High level of humidity and coolness prevailing in the casemates cause scaling of the faces of the bricks. Masonry elements are performed as a filling, distinguished significantly in terms of the brick class and the mortar quality. The cavalier casemates at level -2 represent a stable system without the risk of failure

occurrence.

Photo 15 View of the casemates vault painted with tar

Photo 16 View of filler wall structure



## Casemates at level -2 outside the cavalier part

It is possible to get to the casemates at level -2 from level -1 of the casemates, via a winder staircase. A brick staircase with an arched ceiling performed in the wall between the levels.

Full, semi-circular arched ceilings with the thickness of one brick, with numerous defects and biological corrosion, both of the brick and the lime mortar.

Inside the rooms of the casemates visible condensate water, which are the result of condensation and penetration of precipitation water. The water seeping through the bastion terrace and then through the ceilings causes the washout of the mortar, and the salts dissolved in it cause a slow and systematic destruction of bricks. An additional cause of the degradation of load-bearing arches is the frost erosion resulting from the relatively small embankment.

Casemates marked with (-2,12) and (-2,14) are covered with overlapping arches with different spans and levels. An offset created at their connection indicates the boundary of the originally capped rooms. The wall closing the space between the vaults suggests that each of the vaults was performed at different times. The vaults include ventilation openings protected with steel elements. The casing of the shaft is performed as a round one with a diameter of 80-90cm.



After the performance of pits in January 2014 by a team of archaeologists and architects, it was possible to determine the actual thickness of the vaults and the layers of soil embankments. Arched ceilings were executed in the form of one layer of bricks laid vertically, thickness about 28-29cm, covered with a layer of soil with the thickness of 25cm in the higher part, and 50cm in the lower part. Vaults reinforced with a buttress of bricks placed on the side chisels, with the thickness of 14cm and the width of 48-49cm. Due to the likelihood of disruption of the vault work, when removing a further part of the embankment, the distance between the buttresses has not been specified.

At the height of the upper edge of the higher vault, directly beneath the layer of soil, there is a brick floor made of bricks placed upright, bonded with lime mortar. A detailed description of the conducted works is included in the survey on the terrace of the Król Bastion, performed on 21-22 January 2014 by the museum archaeologist Krzysztof Socha, MA, and Marcin Wichrowski, MA, with the assistance of Janusz Nekanda-Trepka, MSc architect, and Konrad Wesołowski, MSc architect.

Despite numerous defects and brick corrosion, the overall technical condition of the vaults over the casemates (-2,12) and (-2,14) is defined as good. Most of the visible defects do not threaten stability. However, it is necessary to undertake works connected with securing and improving the condition of the bearing elements.

Photo 17 View of the arch beams performed in the form of a single layer and two layers of bricks laid vertically

Photo 18 View of the arched vault between the casemates, with numerous defects in the bricks



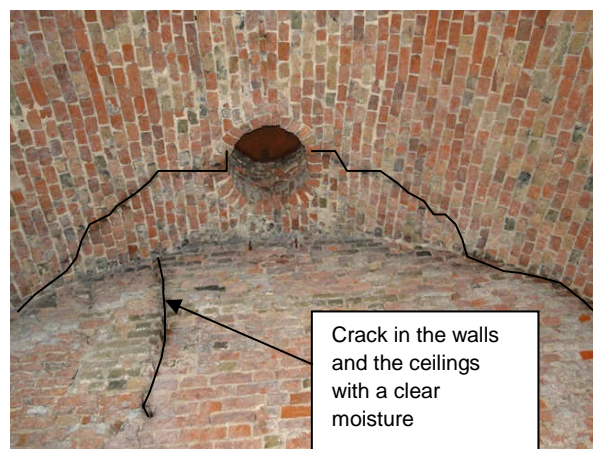
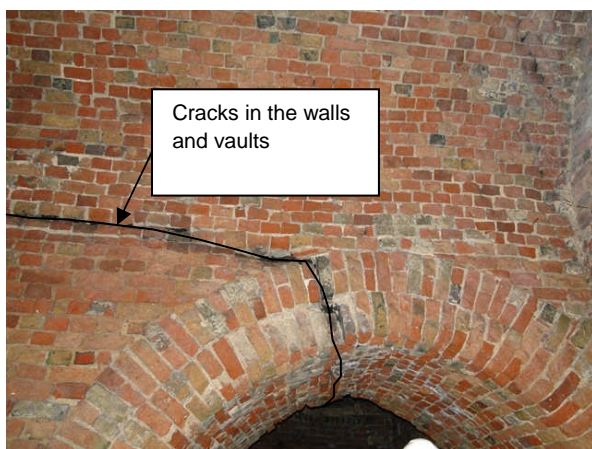
Photo 19 View of the overlapping vaults from the inside of the casemates

Photo 20 View of the step on the vaults of the casemates from the outside



Photo 21 View of the cracks in the walls and the vault over the entire width of the wall

Photo 22 View of damp cracks in the area of the casing



The ceiling over casemates (-2.15) is definitely in the worst condition, and the losses found there reach half of the ceiling thickness. Due to high humidity, the bricks of the vault are brittle, with a visible decomposition of the brick structure. The ceiling is covered with a layer of soil of about 200cm. Observations inside the casemates have confirmed that the technical condition of the ceiling varies. A large slenderness of the structure in the area of extensive damage suggests an impending failure or damage of the structure. The lack of ceiling protection may cause further corrosion and loss of

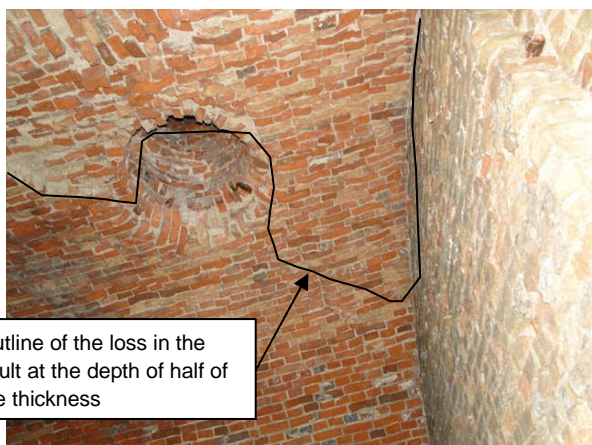


stability. On the basis of the conducted analysis of the arched ceiling for the weakest brick and mortar, taking into consideration the existing losses, it is stated that any interference in the embankment soil of the ceiling may cause the loss of its stability. In order to avoid the possibility of failure of the facility, it is assumed that a demolition of the damaged vault should take place, along with the performance of a new one with the use of a new formwork in the form of arch centres, of planks set on longitudinal beams. Making such a decision is dictated by the experience gained during the work carried out on the Filip Bastion. The applied solution of reinforcing the vault, in the form of a reinforced concrete vault laid directly on the existing vault takes the total load but has a negative impact on the physics of the structure.

Due to numerous losses in the ceiling and strong corrosion of the bricks, the solution of reinforcing the vault with the use of the spraying method (concrete spraying) will not meet its purpose also in this case. This method requires a properly prepared substrate, which is not possible in the case of such strong corrosion of the bricks. The vault must be level and free of loose fragments.

Photo 23 View of the vault loss at half the thickness in the area of the ventilation opening

Photo 24 View of the ceiling loss in the area of the walls



Outline of the loss in the vault at the depth of half of the thickness



Outline of the loss in the vault at the depth of the whole brick

Photo 25 View of the vault loss and mineralised brick in the wall

Photo 26 View of the brick loss at the connection of the walls with the vault

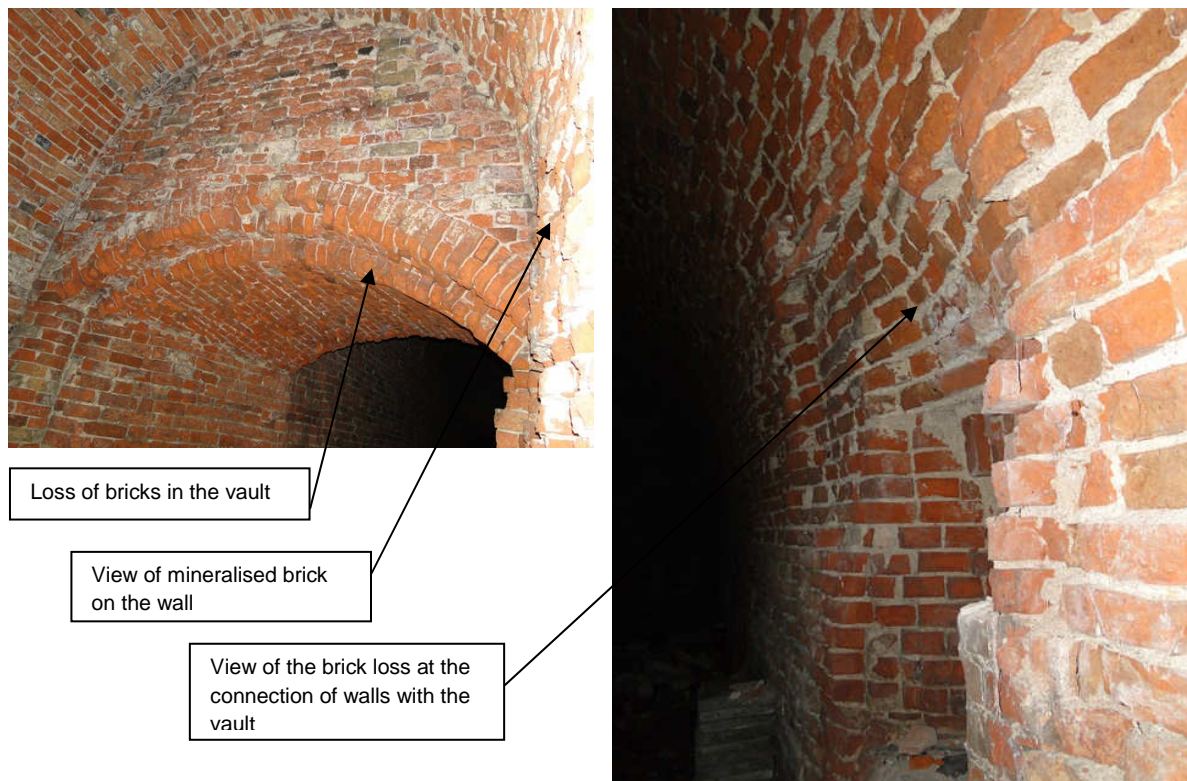
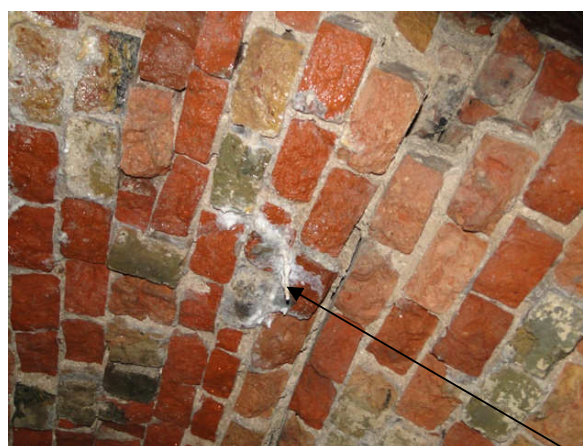


Photo 27 View of the salt efflorescence on the vault, occurring as a result of precipitation water penetration and high air humidity.



View of brick destruction under the impact of precipitation water penetrating the vaults and mineral salts dissolved in it



# FORTE CULTURA

Capitalising of fortified cultural heritage for sustainable development and competitiveness of cities and regions



Photo 28 View of corroded steel elements

All the floors in the casemates rooms are performed with bricks on the ground.

In the casemates, all the metal elements, such as doors or hooks are significantly corroded due to high air humidity.

## 4. Analysis and Recommendations

Over several years and due to warfare, the casemates have been partially destroyed which is visible in the weathering and destruction of brick fragments and degradation caused by precipitation water moisture. The bricks in the lower part of the wall are wet through the constant contact with the Oder River. Numerous damp spots and local defects in the bricks have been found inside the rooms on the inside walls and ceiling vaults.

On the basis of the conducted inventory of the existing state, the walls and ceilings, the overall technical condition of the discusses elements of the Król Bastion of the Kostrzyn Fortress is assessed as stable, without a threat of a disaster. However, it is necessary to emphasise that the stay of unauthorised persons is prohibited. The frequent corrosion of the bricks and their detachment can cause death or permanent disability. The facility qualifies for the planned conservatory renovation. The structural elements require full preventive and reparation maintenance.

**Prior to the conservation works, it is necessary to perform architectural and archaeological tests on a regular basis. Only after identifying the individual stages of the existing condition, it will be possible to determine the detailed repair guidelines for the facility. At the moment, it cannot be excluded that the studies will reveal the relics of the earlier bastion elements, which could expand the scope of the proposed works.**

At present, in order to remove the damage of the existing walls and ceilings of the

Król Bastion, it is necessary to perform the following works:

- removing all the vegetation growing on the bastion walls and vaults, destructively affecting the walls and ceilings.
- cleaning the brick elements off lichen and efflorescence.
- elimination of salt efflorescence on walls and ceiling vaults
- gaps and significant cracks should be fastened with stainless steel anchors or connect with a system of brick walls.
- supplementing brick defects in heavily corroded place
- rebuilding the last layers of bricks of the damaged walls
- repair of the external curtain walls and the cavalier
- rebuilding, replacement of mortars, reinforcements, replacement of the whole cavalier face
- restoration of the soil embankment at the wall crown base.
- reconstruction of soil embankments within the area of the bastion
- restoration of the cavalier terrace along with the implementation of the brick breastwork.
- dismantling of the existing arched vault over the casemates (-2,15), and rebuilding it
- implementation of an arched ceiling of reinforced concrete in place of the left barge
- implementation of a new electrical system matching the functions of the facility.
- in order to observe a further degression of the facility, and during works, it is necessary to mount control benchmarks, as well as the indicators of crack opening.
- the wall foundations which will prove to be particularly weakened, should be filled with a stone reinforcing agent based on the extracts of silicic acid.
- due to the likelihood of the occurrence of free space under the stairs, it is necessary to perform a pit in order to verify the structure and possibly strengthen the stairs.

**All the works must be carried out in detail, consistent with the programme**

**of conservation work.**

**Taking into account the condition of the facility, all the works must be performed with extreme caution.**

## **Recreating the soil embankment of the casemates**

Prior to the works associated with the restoration of the soil embankment, due to the existing technical condition of the arched vaults, it is necessary to apply mining scaffoldings. When the ceilings are secured in this way, proceed to the removal of the soil layers along with all the vegetation, to the level of the vault of the casemates. Additionally, it is necessary to expose the inner face of the slopes. The vaults and the fragments of the exposed walls should be cleaned of soil residues. Due to high corrosion and losses in the bricks, the works connected with the removal of embankments should be conducted with extreme caution. It is forbidden to use heavy machinery causing vibration. The ceilings threaten to collapse.

After the completion of cleaning and drying of bricks, it is necessary to perform disinfection with a spray solution to remove mould off the walls. Perform the reinforcements and rebuilding of losses in the walls. On the ceiling prepared this way, it is possible to recreate the embankments in accordance with the detailed architectural guidelines and in consultation with the conservator.

Drainage of the surface waters should be conducted outside the face of load-bearing walls.

## **Removal of salt efflorescence in the bricks:**

The wall has numerous bricks which were disintegrated under the impact of moisture and high content of soils soluble in the water. The long process of absorbing ground waters with sulphates and sodium chloride not only dampened the walls and ceilings, but also caused their salinity. This can be seen, among others, by the formation of white salt efflorescence and grey spots, and the subsequent disintegration of the bricks.

The walls require desalination with the method of free migration to the extended

environment. After cleaning the bricks with water, apply a compress based on cellulose pulp, sand and bentonite with the thickness of about 1cm. Use demineralised water to make this agent, wait until it dries out completely on the wall, and then remove. Measure the salinity again. The wall desalination should be repeated if the test results still confirm high levels of wall salinity (over 0.5%).

In order to protect the structure against any further appearance of salt efflorescence, the facility must be first of all protected against the constant moisture at the wall crown, through the controlled discharge of precipitation water from the soil embankments as well as damp-proof ceilings.

## **Removal of mosses and lichens:**

It is necessary to apply chemicals to thoroughly remove lichen and moss. When conducting the walls, all the mineralised bricks should be removed and replaced. Discolourations should be removed by means of heated steam. Black spots for fungus should be removed with 15% of perchlorate or calcium hypochlorite. Places of contamination should be treated with a biocide. The treatment to destroy microbes should be performed in places where the micro-organisms grow, by saturating the surface layers of the wall to the depth of one centimetre, with a biocidal preparation.

## **Repair of cracks and scratches of the wall:**

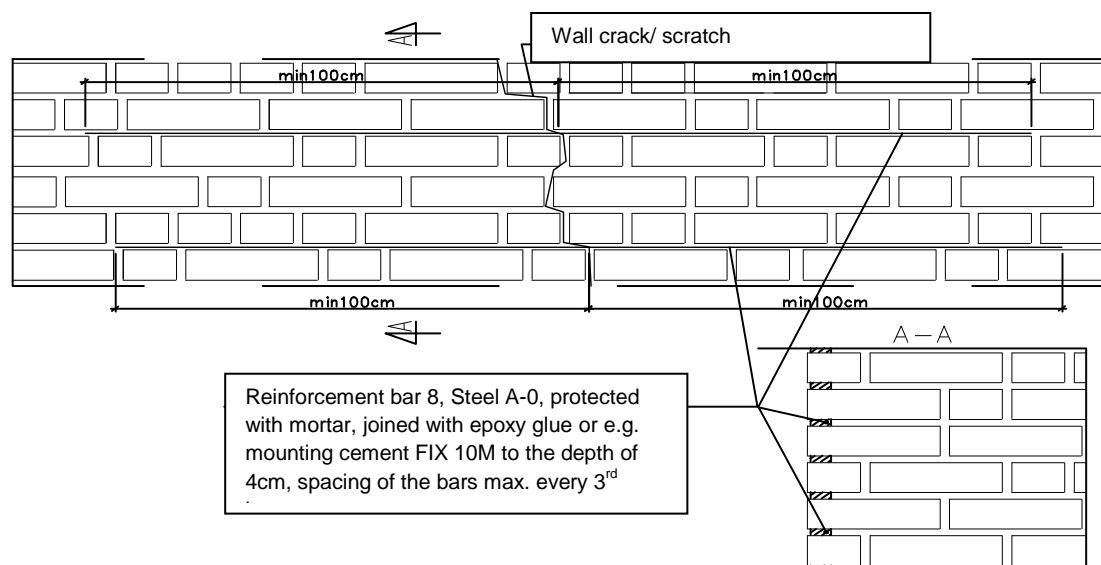
### **Reinforcement:**

- Before the reinforcement of the element, filling the cracks and scratches with special mineral mortar for bricks.
- Remove the plaster from the wall (at least 50cm on both sides of a cracks or scratches) if the plaster is present at a given section.
- Remove the mortar from the joints at the depth of 4-5cm (at least 2-3 joints over and under the crack).
- Thoroughly clean the welds and wall surfaces as well as corroded and damaged bricks.
- Joints should be filled with epoxy mortar
- Push a threaded galvanised steel rod with a diameter of 6mm, protected additionally with anti-corrosion mortar, to the depth of 3-4 cm. It should



be remembered that the rod should overlap at least 100 cm at each side of the crack/scratch.

- Joints in the bricks should be filled with a special grout for making joints in historical walls. Substrate preparation: The substrate must be bearing, clean. Stable and free from dirt and substances which lower its bond strength. (especially in the case of hand-formed bricks and with rustic appearance) Loose particles remaining on the surface will weaken the bond strength.



## Masonry works at the walls

The reconstruction of the walls should be conducted on the basis of historical photograph or drawings to determine the original appearance of the facility and the slopes. Continuous elements, like cornices should be recreated with the use of a stored pattern. All brick mortars can be used in agreement with the conservator.

## Repair of the external curtain walls and the cavalier

In the first place, it is necessary to remove vegetation from the face of the wall by carefully reaching the maximum rooting. If it is impossible to completely remove a part of the roots, it is recommended to use chemicals destroying vegetation. The

plaster on a wall fragment should be removed.

Removal of weathered joints to a depth of at least 3cm and cleaning with steel brushes, re-grouting with the use of a mortar which corresponds with the colour and texture of the existing joints. Supplementing the losses in the wall face and stitching the cracks, with the use of properly dimensioned bricks. The existing gap between the concrete band and the slopes in the basement part should be supplemented with a mortar containing a hydrophobic agent.

After complementing the wall fragments, it is necessary to proceed to refilling the joints. All the joints which are falling apart, and secondary cement grouts should be removed mechanically (grout cutting, slotting or milling method). The brick edges cannot be damaged when using this type of treatment. The brick wall grouting should be performed with the use of lime mortar with suitable capillary and mechanical properties (absorption above 20%, compressive strength 4-5 MPa). Owing to their function in the wall, joints should have lower mechanical strength and higher absorption than bricks. The grout colour should match the original grout or to the overall aesthetic image of the wall.

## **Implementation of a new brick vault:**

The renovation of the existing vault will be based on the restoration of the original state. The demolition of the vault and building a new one is aimed to bring the facility to the proper technical condition, maintaining its current purpose.

Before removing the layers of soil, it is first of all necessary to support the vault using arch centres of planks set on longitudinal beams by means of wedges. The wedges will be used to easily remove the arch centres after the masonry works at the vault.

Then it is necessary to proceed with the removal of the trees growing on the upper terrace of the casemates, the roots of which affect the structure of the vaults. Felling is recommended to be carried out at the ground, and then proceed to remove the roots. Works should be carried out with extreme caution. Using heavy machinery, such as excavators, could cause a loss in stability of the vault. It is recommended to use less invasive devices.

After removing the vegetation and soil embankments, it is possible to proceed to the demolition of the vault.

It is possible to perform a new vault after the preparation of the ground. The arc should be performed in a planking based on arc centres, and the bricks should be laid in accordance with the binding of the walls. The masonry works at the vault should be performed in two abutments simultaneously, the ending should be performed in the form of a keystone in the vault key. Proper execution of joints, perpendicular to the palate of the arch, should be determined with a movable strip or a string tied to a nail located at the centre of the arc circle. The vault should be performed in the form of two bricks laid upright.

The insulation type and the method of covering with a layer of soil should be performed according to the architectural guidelines.

## **Works in the area of the permanent ruins (southern barge)**

In connection with the assumed works, the revitalisation of the Król Bastion – a part of the Kostrzyn Fortress Museum, it is necessary to rebuild the curtain walls and roofing of the south-western barge.

The curtain wall with the width of 3.0m should be rebuilt to the required height ensuring the basis for the designed roofing. The material should be characterised by a resistance similar to the original one.

In order to achieve an appearance of the designed element similar to the original state, the vaults should be performed as arched vaults of reinforced concrete, based on the existing masonry walls and new reinforced-concrete piles placed in the central part of the barge, on foundation ceilings. Due to the unknown system of the underground barge parts, we are unable to determine the detailed foundation. It will be possible only after the performance of architectural and archaeological works.

The vault of reinforced concrete with the thickness of 25cm, in the form of three-span beam, laid on the existing walls and three new piles of reinforced concrete. The levels should be adjusted in accordance with architectural guidelines.

Due to a relatively small arc radius, the load-bearing elements should be

reinforced with ribs in the pile axes. The ceiling should be protected against moisture, with the line discharge of precipitation waters. The cover of the new vault should be performed as a soil embankment in accordance with the guidelines of architecture.

## **Rebuilding the cavalier terrace along with performing the breastwork of brick.**

The first step is to proceed with the removal of wild growing trees and humus. Felling is recommended to be carried out at the ground, and then it is necessary to remove roots.

The soil constituting the outer layer of the terrace should be removed evenly, to the level of the existing structural elements. It is forbidden to perform works with the use of heavy machinery, which could lead to the loss of stability of the vaults. Prior to the masonry works at the breastwork, it is necessary to clean and dry the substrate. The levels of the designed elements should be performed in accordance with architectural guidelines. Within the framework of the cavalier terrace renovation, it is necessary to rebuild the unavailable staircase to the terrace, along with the shell walls. The details concerning the solutions will be available after the performance of the pits.

**All the applied materials must be consulted with the conservation supervisors.**

**To complement the bricks and grouts, it is necessary to apply materials with appropriate parameters (important properties: capillary properties, such as porosity and water absorption, as well as mechanical strength, colour, and texture).**

**It is forbidden to unquestioningly use ready materials which often contain excessive amounts of cement, and thus have poor capillary properties and excessive mechanical resistance. It is recommended to apply materials**

tested by independent research and conservation facilities in Warsaw, Toruń or Krakow.

## 5. Overall Assessment of the Technical Condition of the Casemates.

Currently, the condition of the Król Bastion elements is in stable balance. In terms of its mechanical condition, and taking the aesthetic aspect into account, the facility requires structural repairs, as well as further structural protection. Considering the historical value of the facility, the renovation and conservation works should be conducted under the supervision of a technologist conservator. Architectural and archaeological surveys should be conducted on a regular basis, which would allow us to determine the detailed guidelines for the repair of the facility. At the moment, the proposed works are assumed on the basis of the conducted site inspection. It is necessary to consider that after the implementation of open pits, the scope of the proposed works can be extended. Repair works covered by this study will significantly improve its technical condition and prevent further biological corrosion. Due to its historical background, bringing the facility to its original state requires full preventive conservation and repair.

Prepared by:

Bartosz Januszewski, MSc  
Eng

ZAP/0102/POOK/08

Wojciech Witkowski, MSc Eng

ZAP/0135/POOK/12