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Original Research Article

DAMAGE TO THE FORTRESS IN DANKÓW AND RESTORATION OF KRZEPICKA GATE

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A b s t r a c t

This paper describes conditions of the fortress walls in Danków. Locally they were found to be in very poor condition based on site inspections and non-destructive tests. The previous main gateway to the fortress, that is, the Krzepicka Gate was in the worst condition. Hence, the restoration for the Gate and the plan for its adjustment to become the preserved ruin were prepared. The structure was restored in the years 2021-2023.

Keywords: the 17th century fortresses, curtain walls, conditions, restoration

1. INTRODUCTION

It is very difficult to maintain relevant condition of historic monuments. Properly planned restoration works of historic monuments should be based on analyses of the required maintenance [1, 2, 3]. A lack of immediate maintenance works usually causes worsening the condition and may cause serious damage to a historic monument [4, 5]. The problem concerning the proper maintenance of condition generally refers to big structures, for which such works are very cost-intensive. Structures of significant historical meaning should not be analysed with destructive tests. Various non-destructive tests are helpful in analysing conditions of historic buildings [6, 7, 8].

In the 17th century, the defensive structure of the Polish-Lithuanian Commonwealth, one of the largest states in Europe at that time, was based on fortified objects called fortresses [9, 10]. These were state fortresses (Biała Cerkiew, Kamieniec Podolski, Okopy Św. Trójcy, Żwaniec), private magnate fortresses (Brody, Brzeżany, Dubno, Międzybóż, Nieśwież, Płonne, Słuck, Stanisławów, Zamość), magnate residences in the palazzo in fortezza type (Danków, Krzyżtopór, Łańcut, Pilica, Rzeszów, Zbaraż), monastery fortresses (Berdyczów, Jasna Góra – Częstochowa, Podkamień), castles (Bar, Krzepice, Lubowla, Trembowla) and cities surrounded by fortifications (Elbląg, Gdańsk, Kraków, Lwów, Poznań, Toruń), which, however, were not formally fortresses. Fig. 1 shows the most important

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fortresses of the 17th century. Many of them have survived to this day. However, modern owners and managers of these facilities encounter significant problems with their maintenance. The problems result from the need to carry out renovations of fortresses in order to maintain their proper technical condition [11, 12]. A separate issue is to propose an attractive function that will make the object come alive [13, 14, 15].

This paper describes conditions of a 17th-century fortress in Danków. Its technical condition was determined on the basis of site inspections and non-destructive tests. The building condition was found to be mostly poor. The plan of restoration works was prepared. As this plan was very extensive, only some works have been performed so far. Restorations included the previous main gateway to the fortress, that is, the Krzepicka Gate.

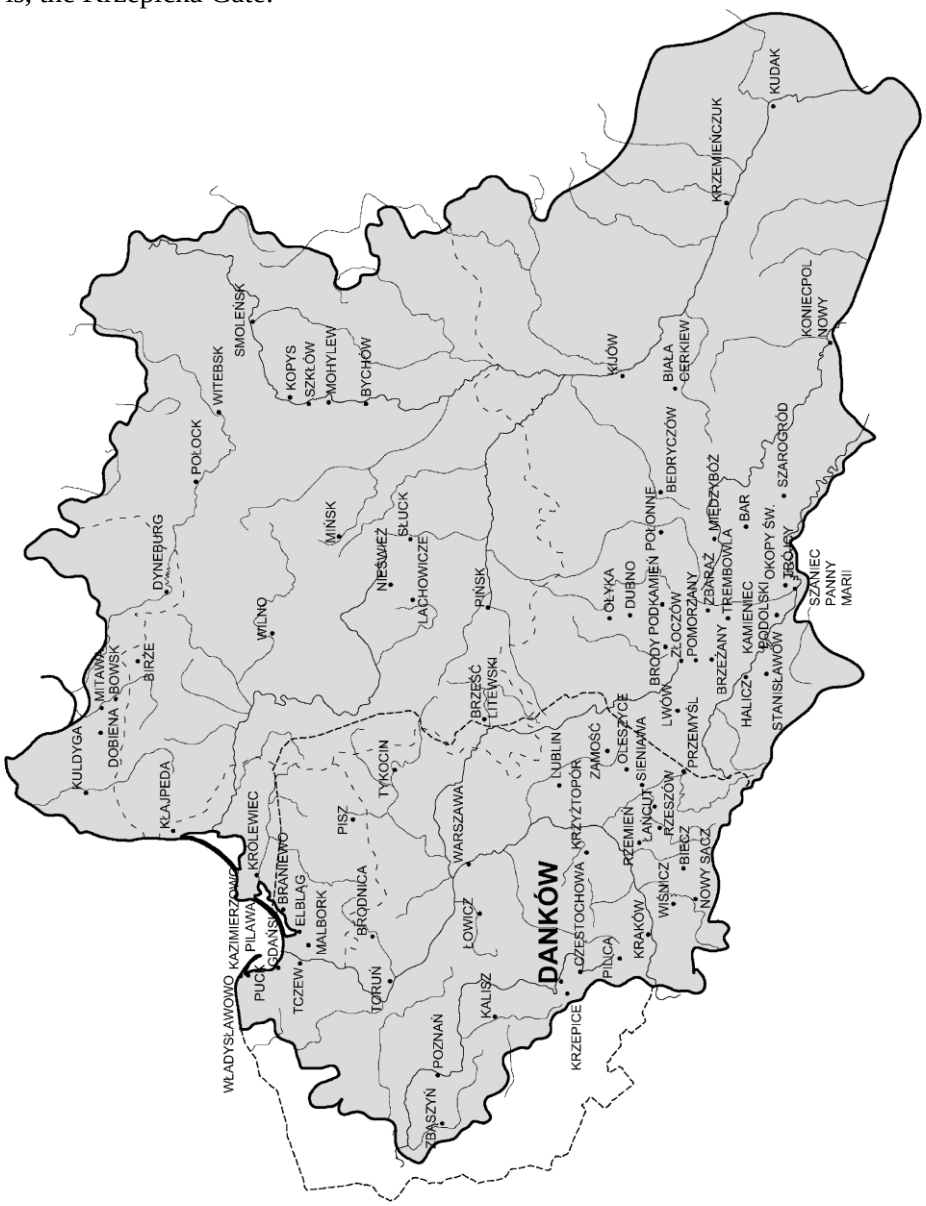

Fig. 1. Fortresses of the Polish-Lithuanian Commonwealth in the 17th century

2. A SHORT HISTORY

Danków was first mentioned in 1217, but the fortress itself was built in the beginning of the 17th century. Then, Andrzej Stanisław Warszycki (1599-1681), a governor of the Mazowieckie Province from 1632 and a Castellan of Cracow from 1651, became a new owner of Danków. On his initiative Danków was extended and fortified. The fortress construction was completed in 1632; however, this date has not been sufficiently documented [9, 16]. Inside the fortress, a masonry church was built, while all buildings and Warszycki's palace were mainly built from timber.

During the Swedish invasion in 1655, the Danków fortress supplied the ordnance of the Jasna Góra Monastery with artillery pieces (12 heavy cannons). In spite of that the fortress was not seized. However, it is unclear whether the fortress was under siege. Cannons were again delivered to the Jasna Góra Monastery in 1702 [17, 18] during the Great Northern War. In 1657, John II Casmir Vasa stayed in Danków with his court, and probably arrived there again in 1665. At that time the fortress had a significant military meaning due to its high defensive potential and a political meaning because of its owner. Danków for a few months served as the political and administrative centre for the Kingdom of Poland and the Grand Duchy of Lithuania. The fortress began to degenerate after the death of Andrzej Stanisław Warszycki, and its military significance decreased due to changes in standards of performing military arts.

Michał Warszycki, a sword-bearer of Łęczyce, became another owner of the castle, which was then inherited by Stanisław (IV) Warszycki, a sword-bearer of the Crown. His daughter, Emercjanna, brought the castle as a dowry to the Hetman of Lithuania, Konstanty Pociejow (d. 1730). After his death, she sold the castle to the Poniński Family of the Łodzia coat of arms. The Wessel Family was another owner of the castle. According to the inventory from 1768, the fortress was abandoned and not used. At that point in time the fortress included a grand masonry church, a kitchen, a destroyed earthen house, and masonry basements (probably the remains of the wooden palace). Farm buildings, a tower, a church roof, and surrounding buildings burnt down in 1767 as the result of fire caused by lightning. The owners moved to Lipie, where they built a manor house, and the fortress in Danków began falling into ruin. The local people took the masonry walls into pieces to build farm buildings. Joachim Kempner took over the indebted domain in the 19th century. In 1823 the fortress was described as the ruin [17, 19]. The archival picture of the fortress from the 19th century is shown in Fig. 2.

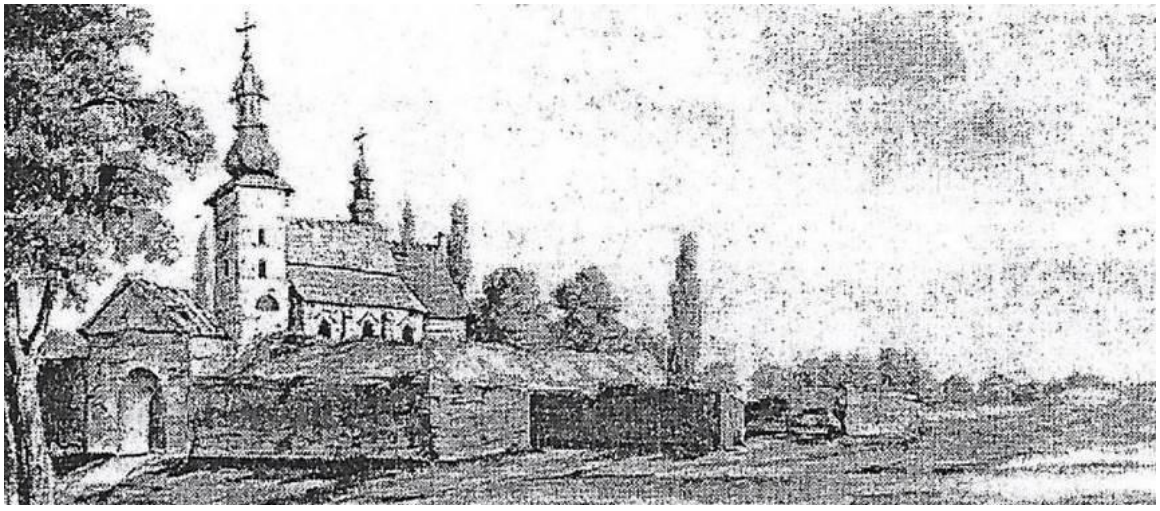

Fig. 2. Picture from the 19th century A view on the Krzepicka Gate (author: Napoleon Orda) [9]

3. DESCRIPTION OF THE FORTRESS

The contemporary fortress in Danków, surrounded with bastions, was erected according to assumptions of the old Dutch and French school. This fortress is one of few examples in Poland of principles of urban fortifications developed by a French fortificator Jean Errard de Bar le Duc [9, 17, 19]. These fortifications were consistent with the assumption of Naronowicz-Naroński, an author of the first Polish book about construction [20].

Along with the works on the fortifications, an artificial lake was formed by damming water in the Liswarta river. Hence, there was no access to the fortress from the south-eastern side. The lake was drained only in the 1970s. Inside the fortress, there was no masonry mansion house, and the main building was wooden. The wooden palace/manor house had been erected before the bastion fortifications. The fortress premises included a masonry house, which could be erected using walls of the previous building, and a kitchen. Among the buildings, the masonry church of St. Stanislaus dominated, whose 40-metre high tower played a defensive role as an observation point.

The masonry of the Danków fortress was made of quarry stones and field stones with lime mortar. Some walls in a second half of the 1970s were faced with brick wall with local inclusions of field stones. Coping of some walls was repaired by applying a layer of tar boards and a layer or two layers of laid flat. A thickness of the fortress masonry is up to 2.0 m and a slope of approx. 82°. The masonry on the inside was strengthened with earth berms. The masonry height ranges from 2.9 to 6.2 m on the south-eastern front and from 2.3 to 5. 3 m on the north-western front.

A layout of the fortification is within a shape of the elongated trapezoid, similar to the rectangle with maximum dimensions of 120 x 210 m, with the longitudinal axis parallel to the course of the Liswarta river. The fortress has two gates on its shorter sides, which were defended by hornworks with two half-bastions. The third entrance on the north-western front is the most commonly used and was built in the 1970s by breaking the wall continuity. A longer front at the north-western side, that is, at the land side, was defended by one giant central bastion. The tenaille was developed at the (south-eastern) side of the artificial lake. Four half-bastions in this front form at the same time two (duplex) tenailled bastions. The south-western, north-eastern, and north-western fronts were surrounded with a dry moat, which could become a water obstacle when water level was raised in the artificial lake. The plan is shown in Fig. 3, and a photo taken by a drone is shown in Fig. 4.

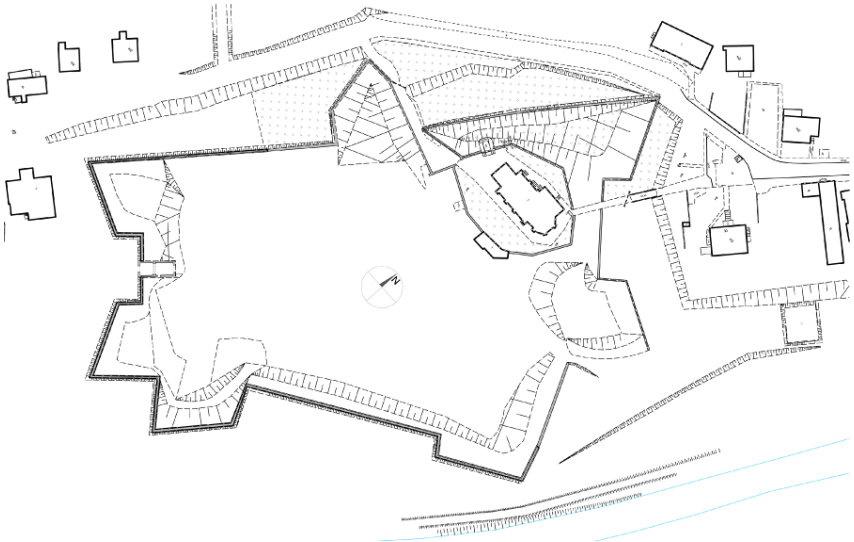

Fig. 3. The current plan of the fortress in Danków

Fig. 4. The fortress in Danków

The south-western, north-eastern, and north-western fronts had a full section typical for bastioned fortifications consisting of (beginning from the outside) the counter-scarp, the moat, the walled scarp and the earth berm with a sconce behind it, Less fortified south-eastern front had the berm with a sconce built only in the area of the south half-bastion. At the end of the sconce at the south bastion, there was a cavalier towering above the whole south-eastern front. The ground slope in the north-western front probably had additional strengthening, which has not survived to the current times due to long-term intensive agriculture activities in that region.

The tenailled and bastion arrangement for the north-western front (the most probable direction of attacks) was chosen to extend fields of fire and its triple crossing on the foreground of the fortress. Dead zones ahead of the bastion and at wings of the bastion are weaknesses of this solution (Fig. 5).

The field of fire of the south-western and north-eastern fronts with the hornwork layout however allowed the concentration of fire on the symmetry axes of these fronts, that is, access roads to gates located in their curtains. The water front, where the close defence was not important due to proximity of the lake, was formed regarding the distant defence (shelling of the further bank of the lake, the path, and devices controlling water level in the artificial lake).

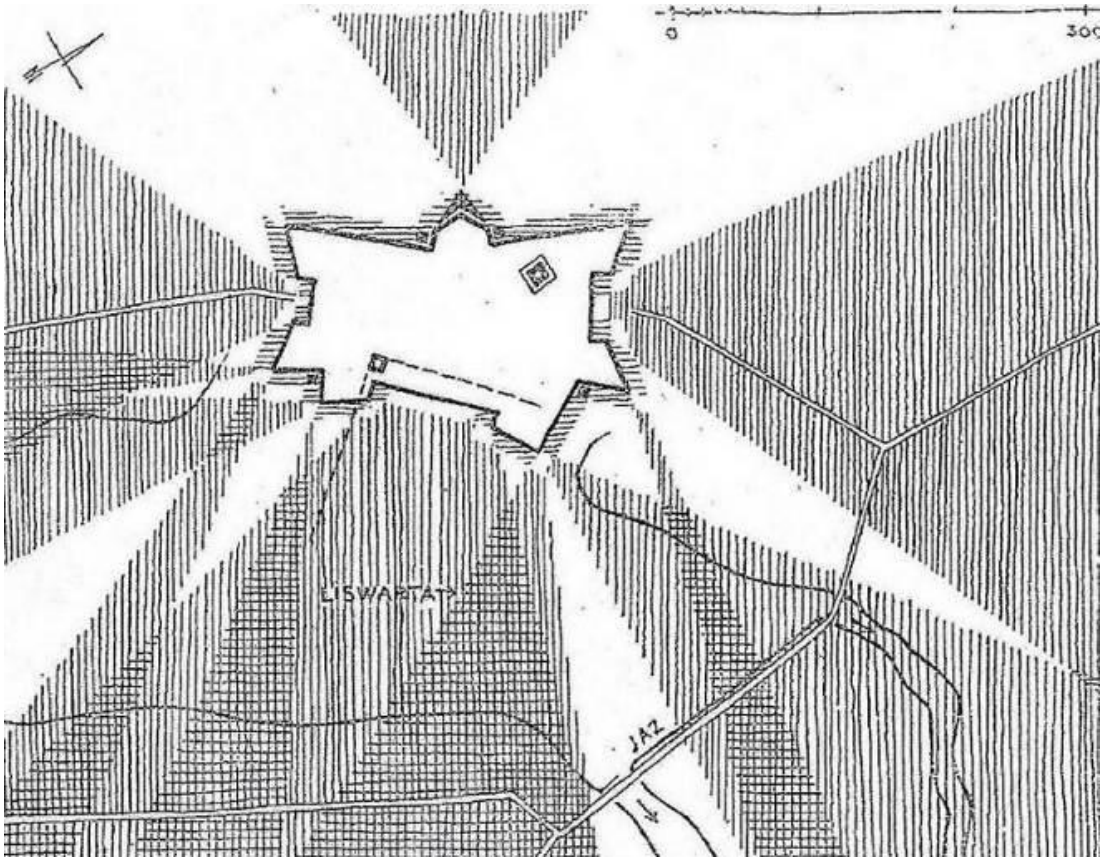

Fig. 5. A drawing of fields of fire of the Danków fortress [20]

The Krzepicka Gate, located in the curtain of the south-eastern front, was the main entrance gate to the fortress (Fig. 6). It was a two-storey longitudinal building with the plan dimensions of 6.8 x 16.8 m. The gate was equipped with a bascule bridge and a portcullis. The area for operators was on the top floor. The upper surface above the passage, in its external part, was made of wood, and the internal part was made as the barrel vault. The masonry thickness is 65 cm and locally thickened in the corners. The second entrance gate, in the curtain of the north-eastern front, has a shape of the tunnel running through the earth berm and the walls (known as the postern) – fig 7. Due to the defence purpose, the tunnel was not parallel to the longitudinal axis of the fortress.

Up to now the original fortress has remained in the form of ramparts of the bastion fortifications, they are earthworks partially faced with the brick wall from the front, ruins of the main Krzepicka Gate, the back (north) gate in a form of the tunnel through the rampart, a single stone wall being a remnant of the rectangular building known as the "Chatelaine's house", a part of wide ditches. The most imposing preserved building is St. Stanislaus' Church, erected by a Castellan of Cracow, Stanisław Warszycki, probably in the second period of the 17th century.

Fig. 6. The Krzepicka Gate (the south-western face of the fortress)

Fig. 7. The gate as a postern (tunnel) at the north-eastern front of the fortress

4. DAMAGE TO THE FORTRESS IN DANKÓW

The inspection of the fortress revealed the following types of damage: numerous losses of masonry units and joints, cracks in masonry, damage to the wall coping, growth of planting on the masonry, damage caused by supplementary pointing with cement mortar. Serious damage and losses of masonry were found for the Krzepicka Gate. The damaged described above is illustrated in Figs. 8÷20. The most serious damage is shown in Fig. 21.

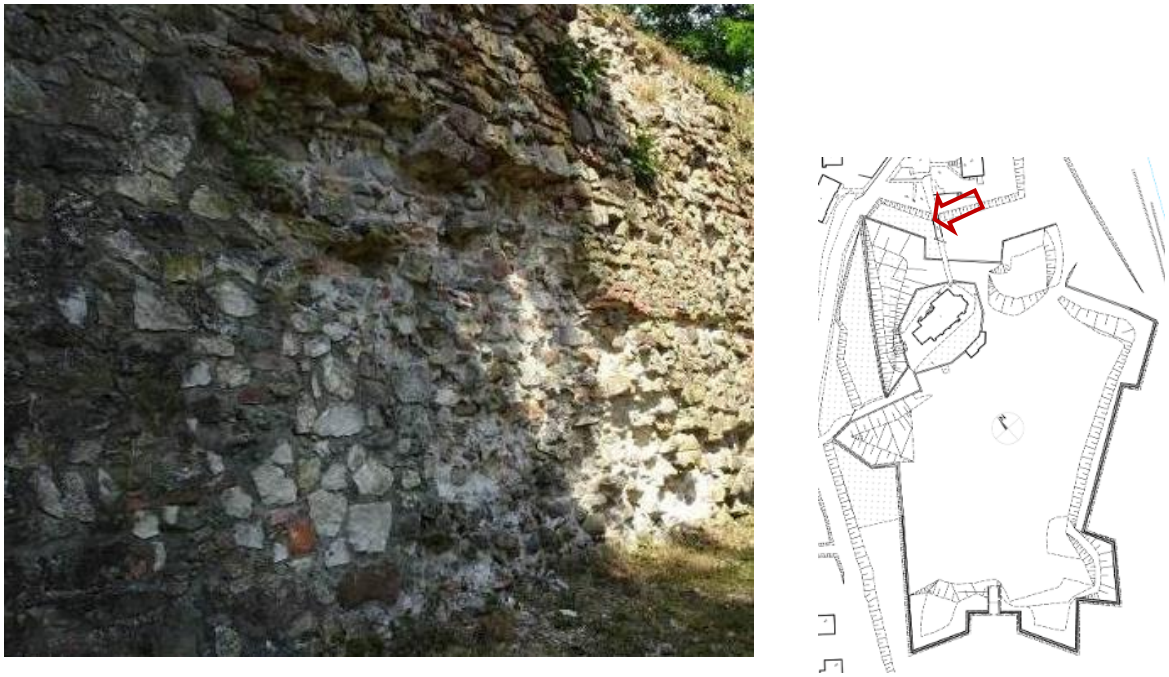

Fig. 8. Loss of masonry units and joints. Growth of planting

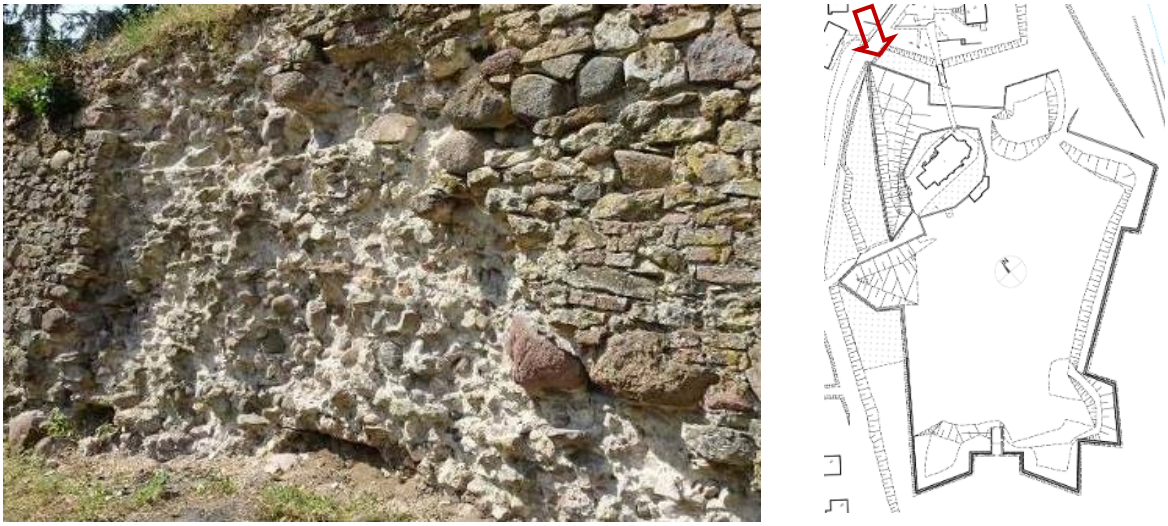

Fig. 9. Loss of masonry units and joints. Growth of planting

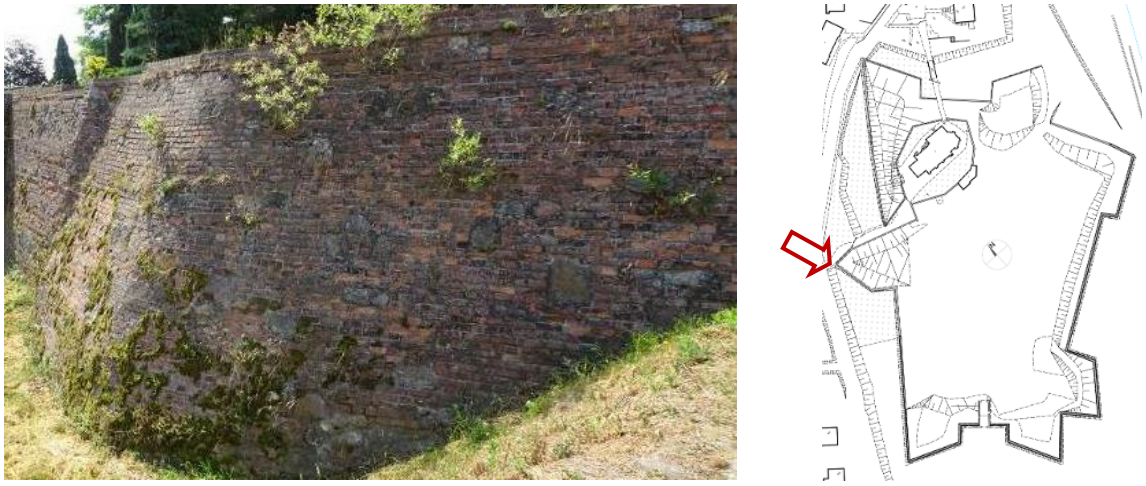

Fig. 10. Loss of masonry units and joints. Growth of planting

Fig. 11. Loss of masonry units and joints. Growth of planting

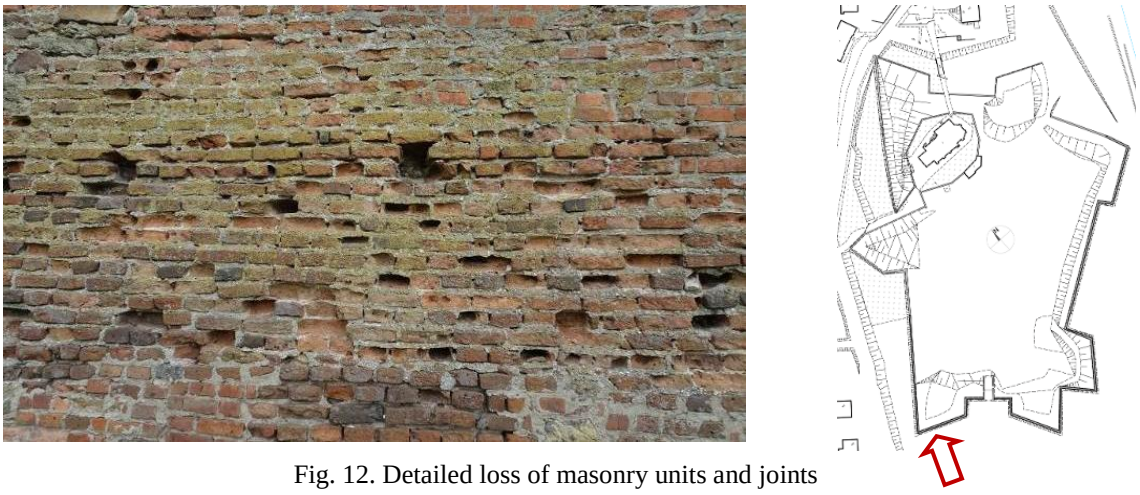

Fig. 12. Detailed loss of masonry units and joints

Fig. 13. A view of damage to the Krzepicka Gate

Fig. 14. A view of damage to the Krzepicka Gate

Fig. 15. A view of damage to the Krzepicka Gate

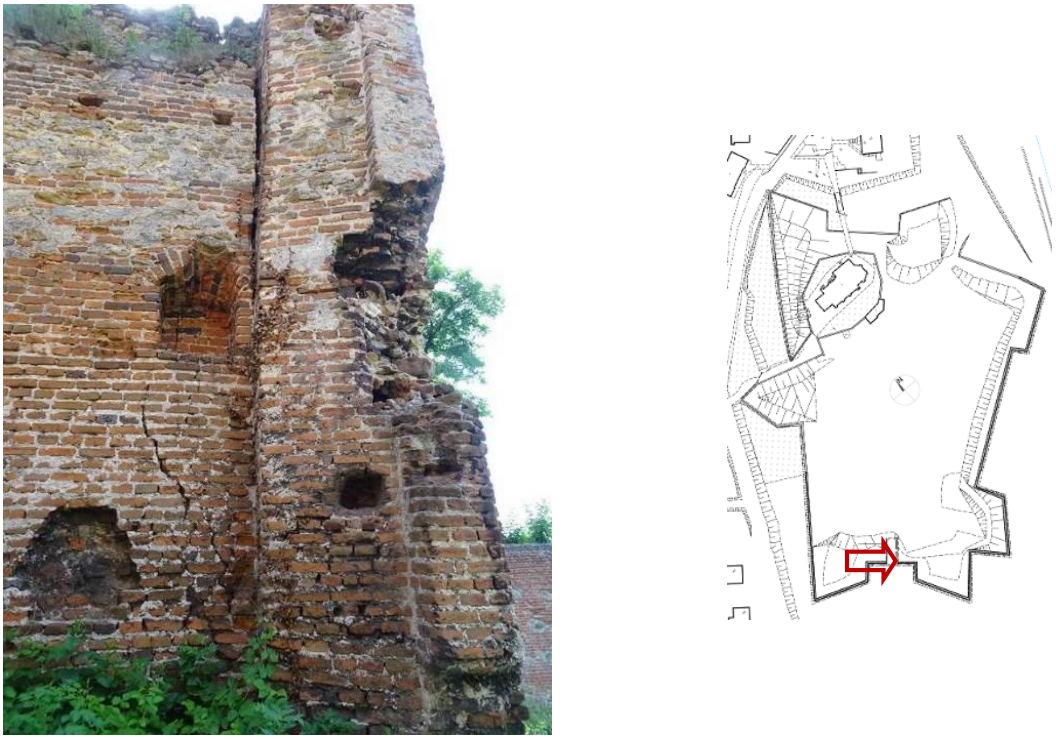

Fig. 16. Cracks and loss of masonry of the Krzepicka Gate

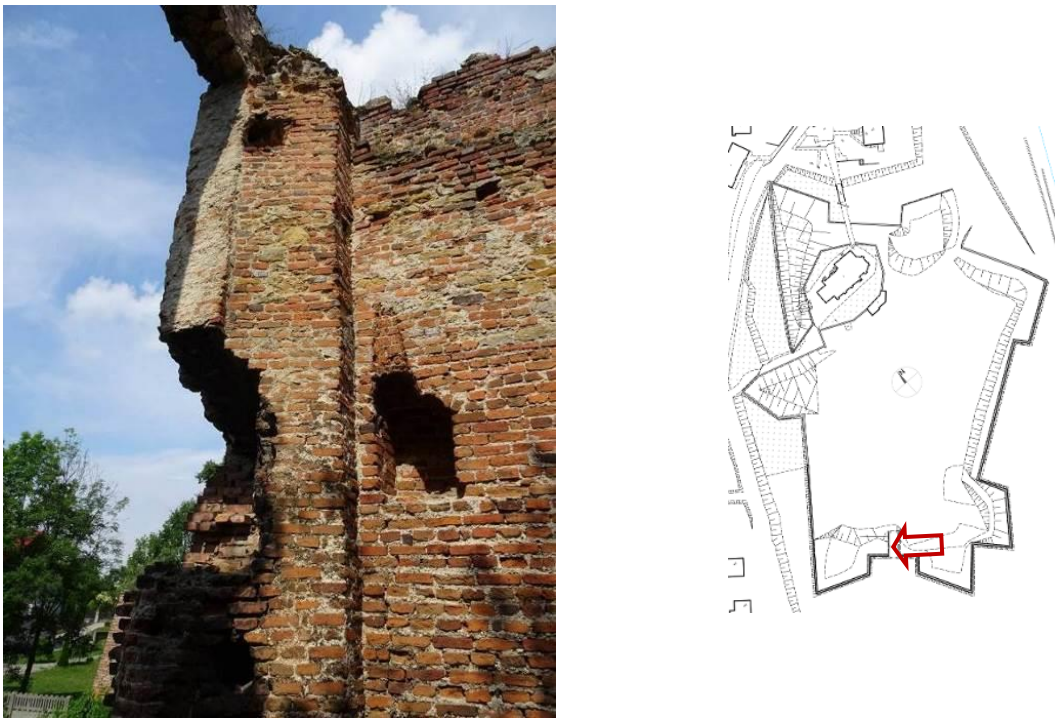

Fig. 17. Cracks and loss of masonry of the Krzepicka Gate

Fig. 18. Cracks and loss of masonry of the Krzepicka Gate

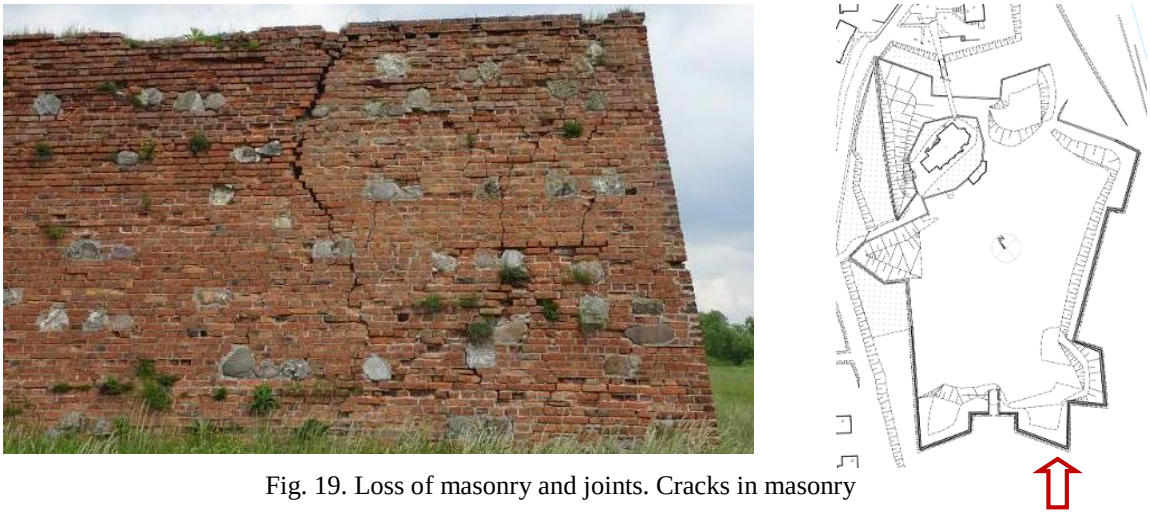

Fig. 19. Loss of masonry and joints. Cracks in masonry

Fig. 20. Loss of masonry and joints. Cracks in masonry

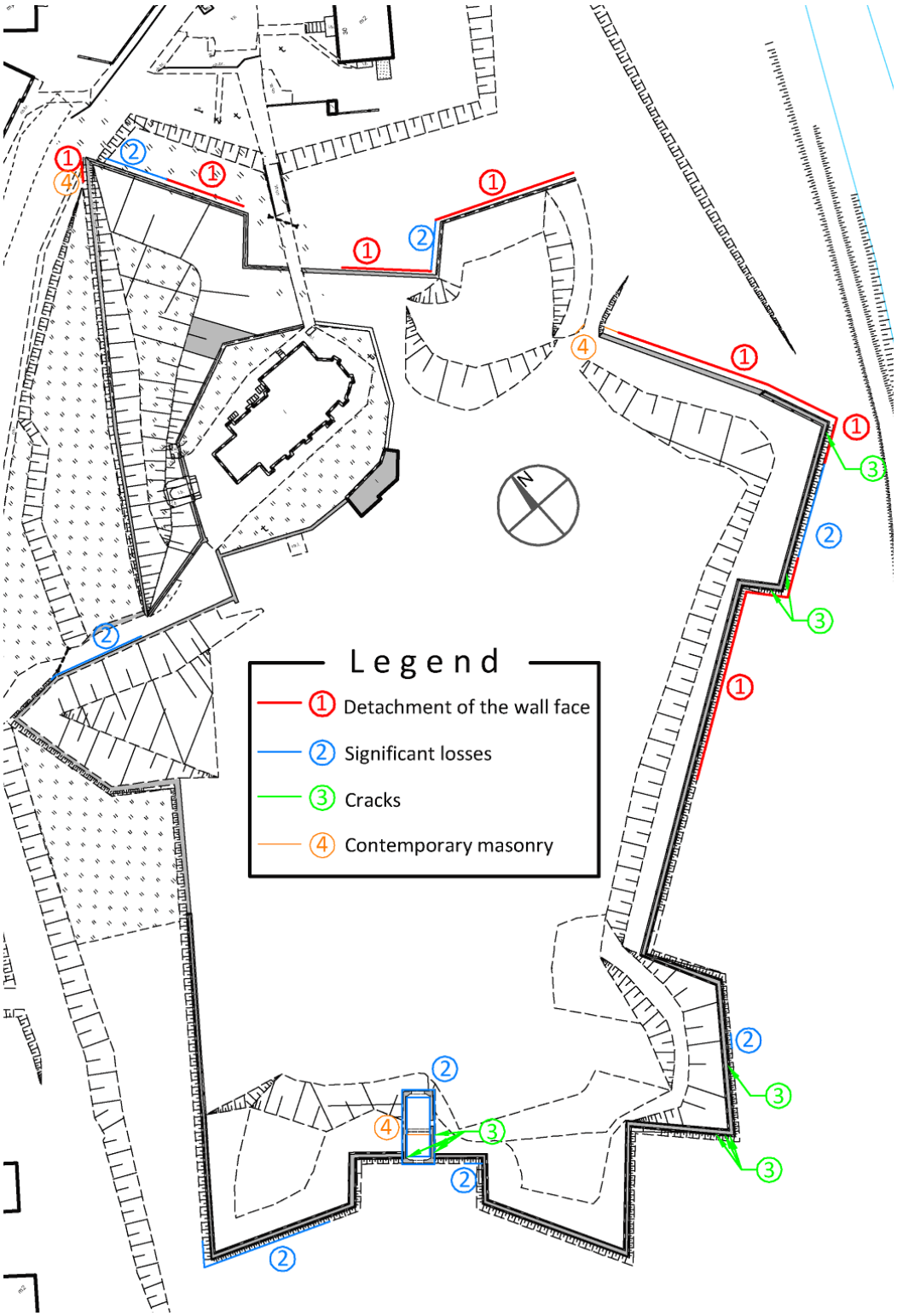

Fig. 21. Locations of most serious damage to the Danków fortress

5. NON-DESTRUCTIVE TESTING

In historic buildings, the use of non-destructive testing is recommended [21, 22, 23]. Moisture content of the fortress walls and the Krzepicka Gate was tested. BM40 and T510 devices operating on the principle of the dielectric measurement method (Fig. 22a and b) and T610 microwave device (Fig. 22c) were used. Wall elements and mortar joints were tested. It is commonly believed that walls with moisture content of up to 3% are dry. Walls with moisture content of up to 5% are slightly damp, while up to 8% are considered damp. Walls with moisture content of up to 12% are considered damp, and above 12% are considered wet. Based on the tests performed, it can be assumed that the fortress wall elements are strongly damp and wet. The mortar should also be classified as strongly damp and wet.

a) b) c)

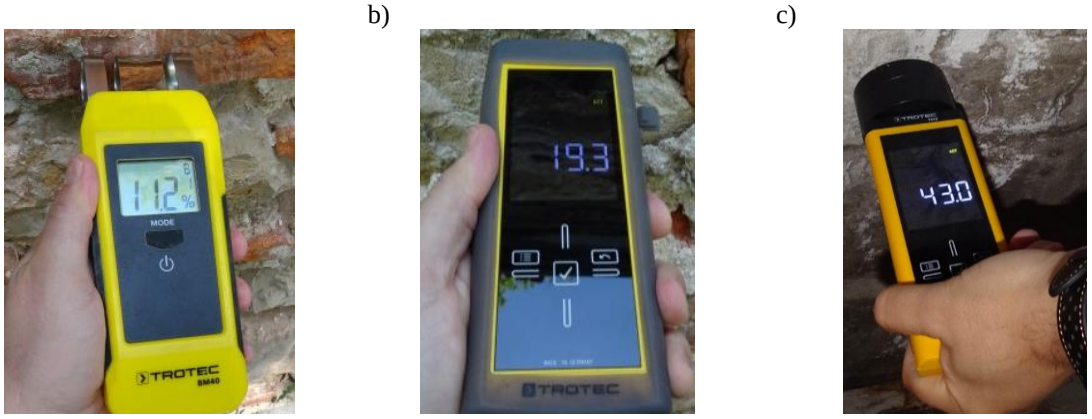

Fig. 22. Moisture tests of masonry elements and joints: a) dielectric method - surface test, b) dielectric method - depth test, c) microwave method

Non-destructive testing of bricks was performed using the UK1401 ultrasonic device (Fig. 23). The test measures the time of ultrasonic wave transit through the tested element between exponential heads installed at a constant spacing of 150 mm. The device automatically calculates the velocity of the transverse ultrasonic wave. Then on its basis, it is possible to determine the strength of the mortar based on the function defining the relationship between the strength of the mortar and the time of ultrasonic wave transit.

Fig. 23. Test of ultrasonic wave velocity

Ultrasonic wave velocities of 1500÷2200 m/s were obtained in the masonry elements. This allows estimating the strength of masonry elements in the range of 10÷20 MPa. A large variability of the test results was obtained (variation coefficient over 20%).

6. CONDITIONS AND A SCHEDULE OF RESTORATION WORKS

The observed damage was caused by normal technical wear and previous repair works performed with wrong materials. Three test pits on joints and microscopic examinations of mortars were performed on walls of the Krzepicka Gate. The masonry was found to be supplementary graduated with cement mortar with additives. The same mortar was used for brick facing which indicates that the repair works were conducted in the 1970s. Lime mortar was found below the supplementary joint in the masonry of the Krzepicka Gate. Supplementary pointing with rigid cement mortar changed the moisture content balance in wall by tightening joints. Transfer of moisture, previously through lime joints, occurs now through masonry units (in this case bricks), which leads to frost damage [24].

Condition of the masonry of the Danków fortress ranges from poor to satisfactory. The following elements are in the worst, often pre-failure, condition: the Krzepicka Gate, parts of the masonry (a northern fragment of the south-eastern front with a half-bastion, a north-eastern front excluding the postern area) without brick facing, faced parts of the masonry (in particular a western part of the south-western front) and crack points on the masonry of the Krzepicka Gate and the north and south half-bastions of the south-eastern front.

The structural design for restoring the Krzepicka Gate was developed, including the schedule of maintenance works [25]. Although two restoration plans had been already developed for the Krzepicka Gate, it was assumed that the Gate was to be maintained as the preserved ruin according to the rules specified in the papers [26, 27, 28, 29]. Over the years, conservation circles have developed forms of securing and revitalizing ruins. These include: minimizing reconstruction work, securing the historic substance, securing the building structures of the ruins, making the most important historical elements legible and making the ruins accessible to visitors. It is extremely important to properly protect the walls from moisture, salts and vegetation growth [29].

The planned restoration and strengthening of the Krzepicka Gate included:

- Stitching of the wall cracks with stitching bas or anchors made of stainless steel. Using anchors for detachment of the facade wall. Filling cracks having a width greater than 1 mm with mineral injection.
- Protecting arches by anchoring stainless steel bars and, if possible, rebuilding and locally supplementary brick laying.
- Placing steel lintel which supports the gate top.
- Restoring two vaults.
- Bricking up ectypal openings.
- Cleaning the wall coping, placing the waterproof membrane, and protecting the wall coping. Laying 1-2 layers of brick above the membrane.
- Removing supplementary masonry made of AAC (Autoclaved Aerated Concrete) masonry units.
- Partial clearing of the floor and performing floor from e.g. stone or rubble.
- Cleaning walls with the blast (or other) method and removing supplementary striking of joints.
- Rebuilding of wall losses.
- Supplementary striking of joints with restoration mortar.
- Performing hydrophobic impregnation of the masonry.
- Placing the steel portcullis.

The planned method of repair and restoration of the Krzepicka Gate is presented in Fig. 24.

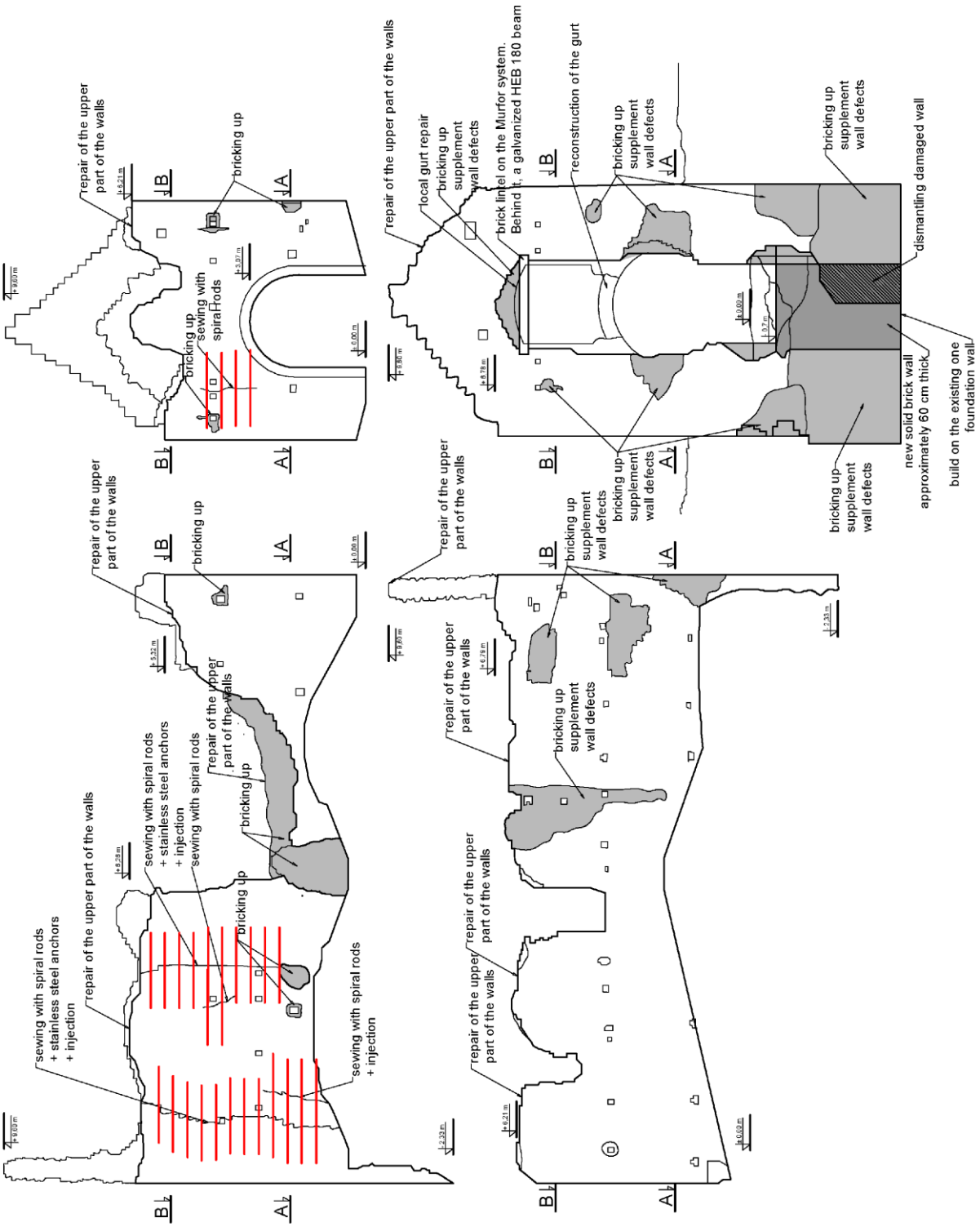

Fig. 24. The planned method of repair of the Krzepicka Gate

7. RESTORATION OF THE KRZEPICKA GATE

The restoration works began in 2021. The following works have not been performed: works on the floor and the portcullis, building the lintel covering the steel bar that supports the masonry over the lintel, brick laying of the masonry above the waterproof membrane at the wall coping. The condition in 2020 and 2024 (after the restoration works) is shown in Fig. 25÷20.

a) b)

Fig. 25. A view of the Krzepicka Gate from the south-western side: a) before restoration in 2019, b) after restoration (2024)

a) b)

Fig. 26. A view of the Krzepicka Gate from the western side: a) before restoration in 2019, b) after restoration (2024)

a) b)

Fig. 26. A view of the Krzepicka Gate from the top: a) before restoration in 2019, b) after restoration (2024)

a) b)

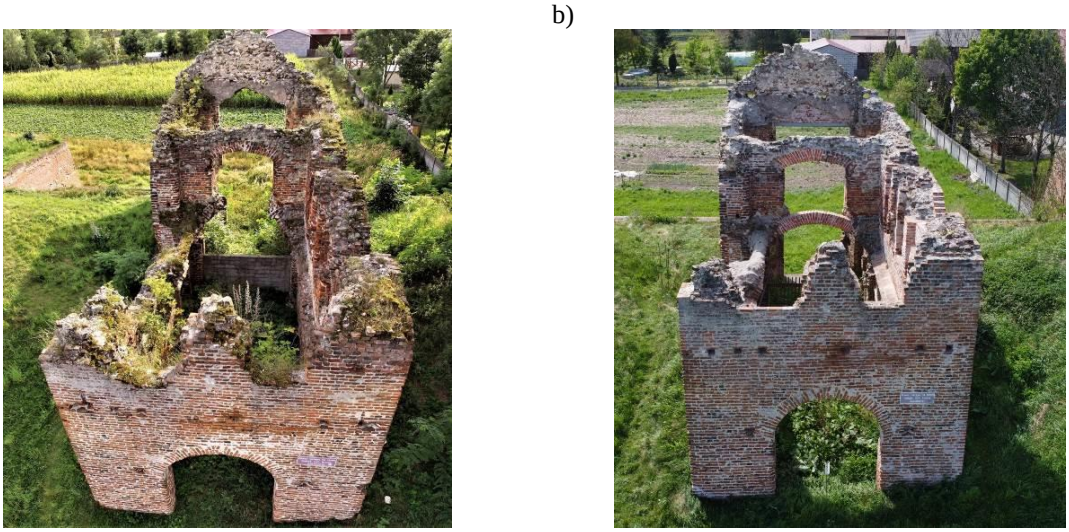

Fig. 28. A view of the Krzepicka Gate from the western side: a) before restoration in 2019, b) after restoration (2024)

8. CONCLUSIONS

This paper describes conditions of the masonry of the fortress in Danków. A lack of performing any repair works for many years resulted in poor condition of this building, and even locally to the pre-failure condition of the masonry, particularly ruins of the Krzepicka Gate. Long-term negligence led to conditions, in which restoration works generated high costs. The gate restoration began in 2021. The aim of the works was to restore it to the condition of a preserved ruin and open up to visitors. The task has been almost completed entirely. The remaining masonry of the fortress also requires urgent restoration works.

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