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PROBLEMS OF CONSERVATION AND REPAIR OF THE WALL CRESTS OF THE JANOWIEC CASTLE ON THE VISTULA RIVER

Wall crests are the parts of historic masonry structures most exposed to the destructive effects of atmospheric and biological factors, which, in the case of the Janowiec Castle—constructed primarily of limestone opoka—results in accelerated degradation. The authors present the development of conservation methods, ranging from historical attempts involving turf coverings and epoxy resins, through technical–biological solutions, to contemporary techniques based on capping masonry, grouting, and insulation systems.

The history of the castle is outlined, from its construction in the 16th century as the Firlej family residence, through wartime destruction and later utilitarian use, to conservation and protective measures undertaken since the 1970s. Emphasis is placed on the importance of preserving ruins with minimal intervention into the original historic fabric.

The technical condition assessment revealed serious damage, including erosion of the limestone opoka, loss of mortar joints, biological corrosion, frost and salt damage, as well as the negative effects of earlier repairs carried out with cement-based mortars. A comparison of documentation from 2010 and 2025 demonstrates ongoing degradation and an increasing level of risk to both the structural stability of the walls and visitor safety.

In the design section, comprehensive solutions are proposed, including masonry rebuilding and strengthening injections, quartzite capping with insulation layers, and protective measures using lead sheet coverings and ceramic fittings. Methods already tested at Janowiec are recommended, as they combine technical effectiveness with the preservation of authenticity and the legibility of the historic structure.

In conclusion, the authors emphasize the need to implement an integrated conservation programme encompassing repairs, monitoring, and systematic maintenance in order to ensure the long-term protection of this exceptional monument.

Keywords: Janowiec Castle; wall crests; conservation of ruins; limestone opoka; wall degradation; wall protection; conservation techniques; defensive architecture; heritage protection; permanent ruin

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1. INTRODUCTION

Wall crests, as the most exposed elements of historic structures, are particularly vulnerable to the destructive effects of atmospheric factors such as precipitation, wind, ultraviolet radiation, and freeze–thaw cycles [6]. Their proper protection constitutes one of the key components of a long-term conservation strategy for historic masonry. Leaking or degraded wall crests facilitate the infiltration of rainwater, which leads to the deterioration of mortar joints and masonry materials [3], and consequently to the weakening of the entire structure. This problem is especially evident in buildings that have remained in a state of ruin for extended periods, such as the Castle in Janowiec on the Vistula River.

In Polish conservation literature, this issue has been addressed, among others, by Domasłowski and Szmidel-Domasłowska [5], who analysed the impact of weathering on wall crests and methods of their strengthening, including the use of protective superstructures and appropriate lime mortars. Their approach provided a point of departure for subsequent material and technological studies. Przyłęcki [11], in turn, emphasised the importance of adequate horizontal protection and the application of capping masonry made of materials compatible with the historic structure, highlighting the need to design technical solutions in close relation to the architectural context of the monument.

In recent years, this subject has become the focus of interdisciplinary research combining conservation science, geology, materials engineering, microbiology, and digital heritage documentation [8]. Particular emphasis is placed on understanding the microstructure of building materials and their response to environmental conditions, especially in the case of highly porous materials such as limestone opoka. Research on biodeterioration also indicates the necessity of controlling biological growth on wall crests and employing biologically mild conservation agents.

In Poland, contemporary methods of protecting wall crests have been analysed, among others, by Trochonowicz [16], who, with reference to bastioned structures in the Lublin region, such as Janowiec, presented complex conservation problems related to limestone opoka as the primary building material. He drew attention to its high porosity, low resistance to alternating freeze–thaw cycles, and susceptibility to biodeterioration and chemical pollution. The author points to the need for integrated diagnostic methods, including non-destructive testing, photogrammetric documentation, and microbiological analyses. The conservation of such masonry requires an individual approach to each section of the wall crest, depending on its history of use, degree of deterioration, and function within the current composition of the ruins.

International experience also provides valuable insights. Examples of wall crest conservation in German, French, and Italian castles demonstrate that success in this field depends on the synergy between traditional methods and modern composite materials, as well as advanced documentation techniques [3].

In light of these considerations, studies addressing the technical condition and repair methods of the wall crests of the Janowiec Castle acquire particular significance. The monument, under the care of the Nadwiślańskie Museum, has for many years served as a model example of a permanent ruin, the conservation of which requires a balanced approach in accordance with the principle of minimal intervention while maximising the preservation of original fabric. The need for a comprehensive approach to wall crest protection is confirmed by numerous Polish and international publications. As early as the 1960s, the classic study by Domasłowski and Szmidel-Domasłowska [5] highlighted the destructive impact of atmospheric conditions and the necessity of experimental protective methods, such as the use of epoxy resins. Another important contribution is the article by Przyłęcki [11], which introduced an innovative turf-based protection method for wall crests, referred to as a technical–biological approach.

Tajchman [15] analysed doctrinal aspects of ruin conservation and discussed the importance of wall crest protection in the context of differences between Polish and English conservation approaches. Jasieńko et al. [9] presented the results of field and laboratory investigations that identified the most common causes of degradation and compared the effectiveness of various protection methods.

Studies by Trochonowicz and Szmygin [18] emphasised the complexity of degradation processes and the importance of material compatibility and aesthetic considerations in conservation interventions. In subsequent research, Trochonowicz and Drobek [17] carried out a comparative analysis of several Gothic castles, demonstrating the long-term effectiveness of the applied methods in protecting wall tops.

In the international context, it is also worth noting the research by Hanssen and Viles [8], who conducted an experimental analysis of the impact of soft vegetative coverings (soft capping) on rainwater runoff. The classic monograph by Ashurst [1] discusses the methodology of the English school of ruin conservation and highlights the significance of wall crest conservation as an element in preserving structural authenticity.

In Poland, contemporary interventions in castle ruins, including wall crest protection, have also been widely discussed. An example is the chapter by Głuszek [7], which addresses aesthetic and functional dilemmas. Stępień [12] likewise presents specific examples of implemented solutions. Szmygin [14] summarises national conservation experience, identifying key problems and good practices. A historical reference remains the classic publication by Cohausen [4], who was among the first to advocate the use of turf to protect wall crests from water. Taken together, these sources provide a solid basis for further conservation analysis of wall crest protection in the context of the Janowiec Castle.

2. HISTORY OF THE JANOWIEC CASTLE

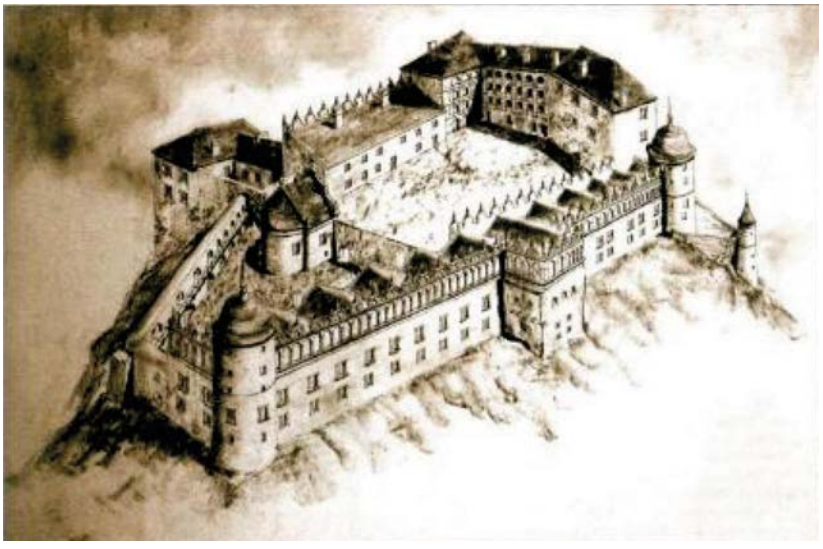
The Castle in Janowiec on the Vistula River was constructed between 1508 and 1526 on the initiative of Mikołaj Firlej, Voivode of Lublin, as a representative magnate residence with defensive functions, situated on a high escarpment overlooking the Vistula River. The structure was built using locally available materials—limestone opoka, brick, and sandstone—and its architecture reflects the influence of the Italian Renaissance, associated with the owners' contacts with European artists and architects [21].

Rys. 1 The Castle in Janowiec on the Vistula River. Drawing by E. J. Dahlberg, 1656.

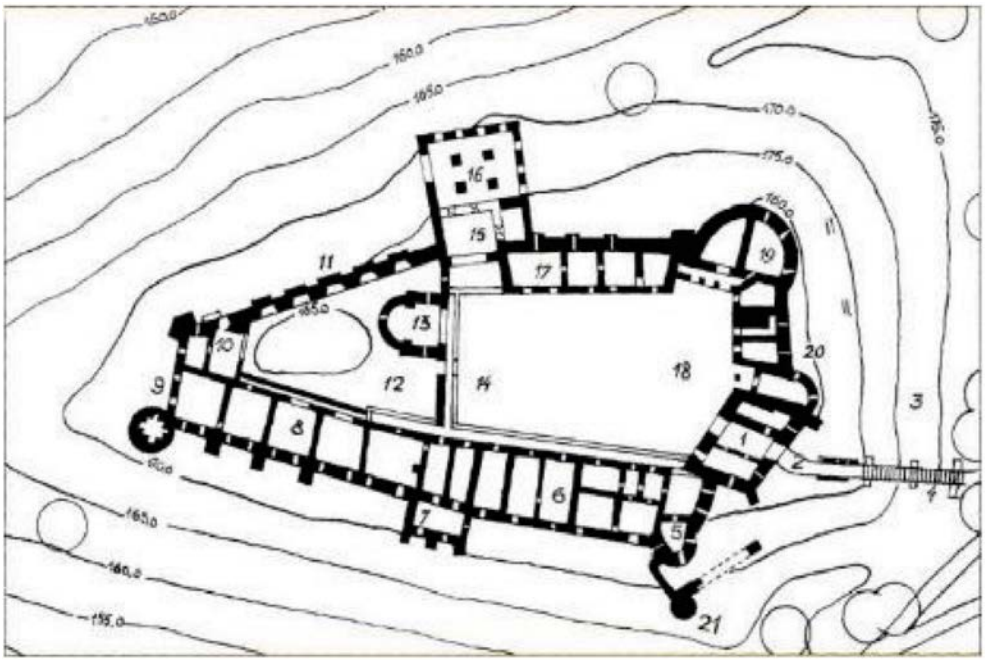
In the second half of the 16th century, the founder's son, Piotr Firlej, continued the construction works, giving the castle a regular courtyard layout and expanding the fortifications in accordance with the principles of early modern bastioned defensive architecture. The castle later passed into the hands of other prominent families, such as the Tarło and Lubomirski families, who introduced new architectural elements. Particularly significant was the contribution of artists such as Santi Gucci—the author of the Renaissance stonework—and Tylman van Gameren, who was responsible for Baroque transformations of the interiors [21].

Rys. 2 Reconstruction of the castle's appearance in the first quarter of the 16th century. View from the south-west. Drawing by T. Augustynek, 1994.

In 1656, the castle was severely damaged during the Swedish Deluge, and its reconstruction was never completed. In the 18th and 19th centuries, the castle was used for utilitarian purposes (as a granary and barn), and its structural elements served as a source of building materials [21].



Rys. 3 Reconstruction of the castle's appearance in the third quarter of the 17th century. View from the south-west. Drawing by T. Augustynek, 1994.



Rys. 4 Castle plan: 1. Gatehouse, 2. Gate neck, 3. Moat, 4. Bridge, 5. Eastern tower (originally a puntone bastion), 6. Southern enfilade, eastern part (Andrzej Firlej Palace), 7. Southern residential tower (southern risalit), 8. Southern enfilade, western part (Tarło Palace), 9. Western tower, 10. Western apartment, 11. Northern defensive wall, 12. Small Courtyard, 13. Chapel with well, 14. Cloisters, 15. Northern residential tower (demolished in the 17th century), 16. Servants' quarters (northern outbuilding), 17. Northern House, 18. Great Courtyard, 19. Great bastion, 20. Eastern wing, 21. Small tower on the subwall. Drawing by T. Augustynek, 1995.

A new chapter in the history of the monument began in 1931, when the castle was purchased by Leon Kozłowski—an art historian and archaeologist—who undertook the first attempts to protect the site. After the Second World War, the castle fell into increasing ruin until, in 1975, it came under the care of the Nadwiślańskie Museum in Kazimierz Dolny. Since that time, architectural and archaeological research, as well as gradual protective works, have been carried out [13].

Technical measures to secure the castle ruins commenced in 1976. Initially, ad hoc protective measures were applied, including temporary props, tensioned cables, and provisional masonry infills.

In 1978, following the preparation of the first design documentation for the eastern wing by the Warsaw branch of PKZ (State Enterprise for the Conservation of Monuments), the implementation of permanent protective measures began. However, in 1988, the museum abandoned the PKZ concept, considering it to involve excessive interference with the historic fabric due to the use of modern structural solutions.

The services of PKZ as a contractor were also discontinued, and the works were entrusted to local craft workshops.

Between 1988 and 1994, intensive conservation activities were carried out, resulting in the structural stabilisation and conservation of approximately 90% of the castle walls. Weathered wall crests were strengthened with quartzite, a material harder than the chalky limestone opoka; window and door lintels were rebuilt; and

Photo 1 Wall of the gate neck. 2010.

Photo 2 View of the courtyard and the southern enfilade.

structural solutions such as concealed reinforced concrete ring beams, prestressing, and bonded anchors were applied. All works were conducted in such a way as to minimise interference with the original structure. In 1995, the reconstruction of the Northern House was completed; it was erected almost entirely on preserved historic foundations and currently serves a conference and museum function.

Today, the Janowiec Castle represents one of the best-documented examples of permanent ruin conservation in Poland. It is not only an important example of Renaissance residential–defensive architecture, but also a valuable field for contemporary conservation, architectural, and archaeological research.

3. TECHNICAL CONDITION

The technical condition of the wall crests of the Janowiec Castle on the Vistula River must be assessed as seriously endangered, with the scale and character of deterioration varying depending on location, exposure, and the original building material. The upper sections of the perimeter and bastioned walls, which are particularly exposed to direct precipitation, wind, freeze–thaw cycles, and solar radiation, show clear signs of advanced degradation. This deterioration includes both material losses and structural damage.

In many sections of the wall crests, symptoms of loosening and structural disintegration are evident: individual stones have become displaced, and cracks and transverse fissures have developed, leading to a loss of cohesion within the masonry. The binding mortar frequently crumbles, facilitating further moisture penetration and intensifying destructive processes. Particular attention should be paid to numerous surface cavities and losses, some of which reach depths of several centimetres and pose a direct threat to the stability of the wall tops.

In many areas, intensive stone erosion is also observed, especially of limestone opoka, which constitutes the primary building material of the castle. As a sedimentary rock with high porosity and low cohesion, opoka is particularly susceptible to scaling, cracking, and delamination. Under the influence of prolonged moisture exposure, ultraviolet radiation, and temperature fluctuations, this material loses its integrity, in extreme cases leading to the detachment of entire stone surfaces. The masonry structure also contains sandstone and brick elements, which deteriorate to varying degrees depending on firing quality, water absorption, and exposure to moisture.

The effects of earlier technical and conservation interventions are also visible and, in many cases, were carried out in a manner inconsistent with contemporary principles of heritage conservation. The use of cement-based mortars with excessive stiffness and alkalinity has contributed to the development of local stresses and microcracking in adjacent areas of the original fabric. The replacement of missing material using stone incompatible in terms of structure, colour, and technical

properties has resulted in zones exhibiting differential behaviour under service conditions.

A systemic problem remains the lack of effective drainage of rainwater from the wall crests, leading to their long-term moisture retention. The presence of mosses, lichens, and higher vegetation (such as grasses, herbs, and in some locations even self-seeded trees) indicates persistent moisture in the near-surface zone, which in turn results in biological corrosion of the masonry material and a reduction in its mechanical properties. Capillary rise, typical of walls lacking horizontal damp-proof courses, further exacerbates the problem by enabling the transport of moisture and salts from lower parts of the wall upwards. Salt crystallisation within micropores generates secondary internal stresses and promotes further delamination.

Numerous freeze-affected zones are also evident—primarily on the northern elevations of the walls—manifesting as networks of microcracks and degradation of facing surfaces. During winter freeze–thaw cycles, material expansion occurs, particularly in porous opoka, leading to structural losses and the detachment of entire fragments. As a structural system, the wall loses cohesion, and its static stability may be compromised, especially in areas where mortar loss, stone erosion, and stresses resulting from previous unsuccessful repairs occur simultaneously.

Based on the overall assessment, it must be unequivocally stated that the wall crests of the Janowiec Castle require urgent and comprehensive remedial intervention. The current state of preservation not only diminishes the visual and exhibition value of the monument but also poses a real threat to its durability and to the safety of individuals present within the ruins. It is therefore necessary to implement a repair programme that addresses both structural and conservation aspects, in accordance with the principles of preserving the authenticity of historic fabric and ensuring long-term structural stabilisation.

Additionally, on the basis of two site inspections and photographic documentation prepared in 2010 and 2025, an analysis of changes in the technical condition of the walls over the past 15 years was carried out.

Analysis of the photographic documentation indicates the following:

- In several locations, additional temporary protective structures have been installed to secure the most severely degraded sections of the walls.
- Within the castle grounds, the number of fenced-off areas restricting tourist access has increased.
- Intensive deterioration of the low (secondary) walls of the southern enfilade has been observed. Damage is most pronounced in areas where quartzite capping was not applied.
- A clear increase in the number of failures of the mortar bonding the secondary quartzite capping at the interface with both secondary and historic layers of limestone opoka masonry.
- Significant degradation of the mortar beneath the wall crests in areas where damage had previously occurred; the cracks have reached markedly larger dimensions.

Locally (e.g. in the chapel walls), the capping masonry has become completely detached from the limestone opoka wall core. This condition may pose a safety risk to people in the vicinity of the walls.

- An increase in the number of defects caused by salt crystallisation and frost damage on the surfaces of the wall faces.
- A larger surface area affected by biological corrosion (algae, lichens, mosses). New damage to the wall crests allows greater quantities of water to penetrate into the masonry. Excessive moisture promotes more intensive biological deterioration.
- A significantly greater number of locations where annual and perennial vegetation has developed. Plant root systems cause intensive degradation of the masonry material..

Photo 1 Wall of the gate neck. 2010.

Photo 2 Wall of the gate neck. 2025.

Photo 3 Wall connecting the gatehouse and the eastern tower. 2010.

Photo 4 Wall connecting the gatehouse and the eastern tower. 2025.

Photo 5 Southern enfilade, eastern part (Andrzej Firlej Palace). 2010.

Photo 6 Southern enfilade, eastern part (Andrzej Firlej Palace). 2025.

Photo 7 Remains of walls adjacent to the southern enfilade, western part (Tarło Palace). 2010.

Photo 8 Remains of walls adjacent to the southern enfilade, western part (Tarło Palace). 2025.

Photo 9 Southern residential tower (southern risalit). 2010.

Photo 10 Southern residential tower (southern risalit). 2025.

Photo 11 Northern defensive wall. 2010.

Photo 12 Northern defensive wall. 2025.

Photo 13 Postern gate between the Great and the Small Courtyard. 2010.

Photo 14 Postern gate between the Great and the Small Courtyard. 2025.

Photo 15 Chapel with a well. 2010.

Photo 16 Chapel with a well. 2025.

Photo 17 Quartzite capping of the chapel wall crest. 2010

Photo 18 Quartzite capping of the chapel wall crest. 2025

Photo 19 Walls of the servants' quarters (northern outbuilding). 2010.

Photo 20 Walls of the servants' quarters (northern outbuilding) 2025.

Photo 21 Wall connecting the Great Bastion and the Northern House. 2010.

Photo 22 Wall connecting the Great Bastion and the Northern House. 2025.

4. METHODS OF WALL PROTECTION

Works related to the protection of wall crests are often combined with their partial or complete reconstruction. The selection of a specific method depends on the assumptions of the conservation programme as well as on a number of factors, including the type of wall, its state of preservation, structural system, materials used, and the architectural and conservation concept adopted for the entire monument. Each solution differs in terms of durability, degree of intervention in the historic fabric, legibility, and reversibility.

Application of a new layer on the wall crest. These solutions involve introducing a new layer that absorbs the impact of destructive factors and, in the event of degradation, can be periodically replaced. This group includes:

- Reconstruction of wall sections – a form of permanent protection achieved by rebuilding missing fragments, sometimes up to their historic height. Indigenous or similar materials are used, differing only in detail (colour, format, jointing technique). Three variants may be distinguished:
  - Reconstruction to the original height, incorporating elements of defensive architecture (crenellations, parapets, walkways, roofing).
  - Reconstruction to a height lower than the original, finished with a straight termination, with or without additional roofing.
  - Reconstruction below the historic height, preserving the irregular plasticity of the ruins.
- Capping masonry (overbuilding) – supplementation of the upper part of the wall with several courses of brick or stone. The material may be local or non-local; however, excessive visual contrast may create an impression of artificiality. Capping does not halt degradation but rather "transfers" its effects to the new layer. It may be executed with an insulation layer (providing better protection and easier dismantling) or directly on the historic masonry.
- Protection with mortars or concrete – the execution of a tight protective layer on the wall crest, with the possibility of forming slopes to facilitate water runoff. This is an effective solution, although in the case of low walls it may be perceived as less aesthetically pleasing.
- Technical–green method – the intentional planting of vegetation (e.g. shallow-rooted grasses) on the wall crest following surface levelling and preparation. This method requires regular maintenance and involves the risk of the development of unwanted plant species.
- Protection by covering the wall crest. The aim of these methods is to limit the impact of rainwater. They may be temporary or permanent and include:
- Roofing structures – constructions designed to protect the wall crest from rainfall. These may be temporary (made of various materials and applied locally) or permanent, adapted to tourist use. They are executed, among others, using roof tiles, metal sheets, laminates, or supported by structures without permanent anchorage to the wall.

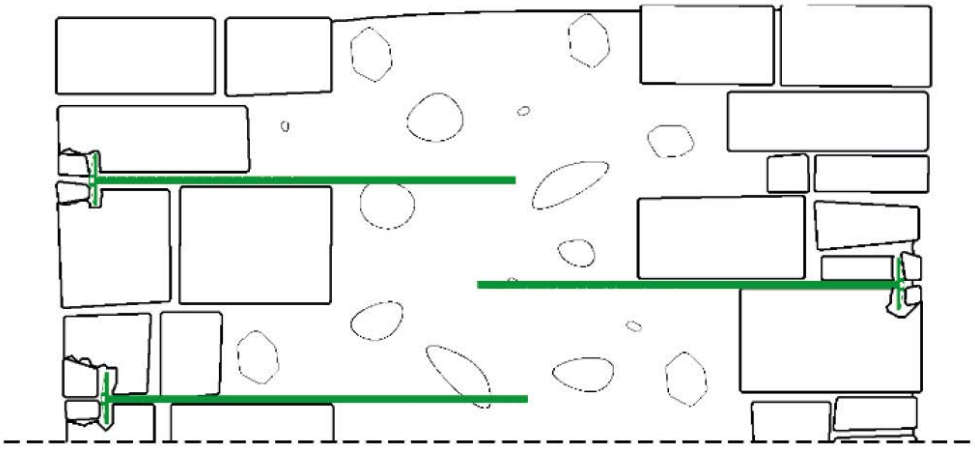
- Chemical protection – hydrophobisation or surface sealing using specialist preparations. This method requires careful substrate preparation, appropriate selection of the agent for the specific material, and adherence to suitable application conditions.

5. PROPOSED METHODS FOR THE PROTECTION OF WALL CRESTS AT THE JANOWIEC CASTLE ON THE VISTULA RIVER

Taking technological and economic considerations into account, the available methods selected for the protection of wall crests include capping masonry and roofing (using lead sheet or ceramic fittings). Both methods have already been applied at the site. An additional advantage is the possibility of reusing part of the materials obtained from the dismantling of existing protective structures.

Methods of repair of the wall directly beneath the crest

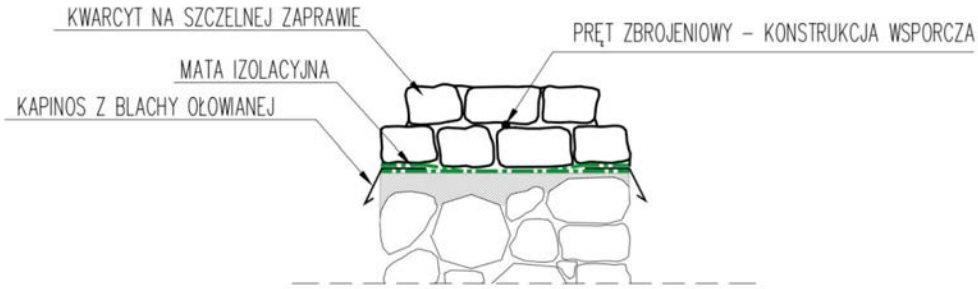
- Rebuilding (repointing and partial masonry replacement) – involves replacing damaged sections of the wall with new masonry. The technology and materials are selected on an individual basis; therefore, a separate technological design must be prepared for each wall section.
- Grouting (injection) – applied to strengthen the wall structure. This method requires the preparation of a detailed design specifying appropriate materials. Drill holes are made in the wall at predetermined spacing, after which the injection material is introduced under pressure. Steel bars are placed in the freshly filled holes in order to monolithise the structure.



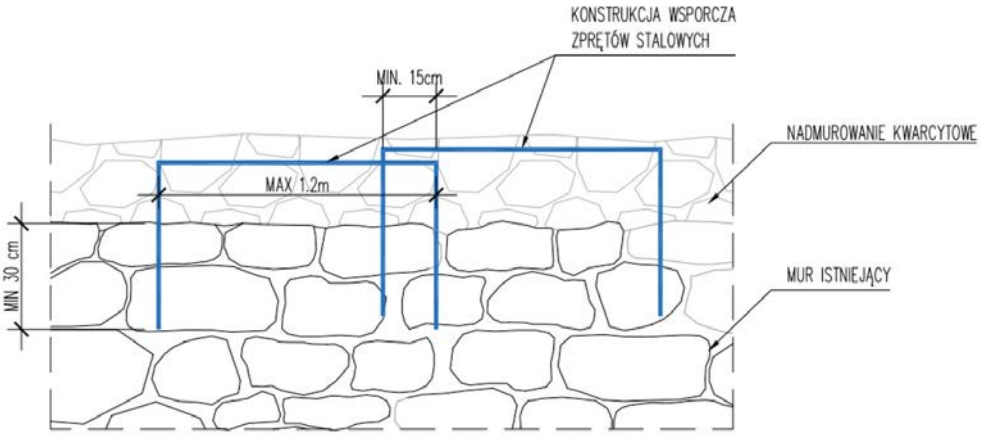
Rys. 5 Diagram of wall repairs beneath the crest. Installation of steel bars within the wall structure following strengthening injection.

Protection of the wall crest by capping masonry

- Quartzite capping with an insulation layer. Due to the deteriorating technical condition of both the existing protection and the wall beneath it, the replacement of damaged sections and the execution of a waterproofing layer limiting water penetration are recommended. The execution of the capping includes the following stages:
  - Dismantling of the existing capping, with the stone retained for reuse.
  - Visual assessment of the technical condition of the wall after exposing the crest.
  - Execution of any necessary strengthening works.
  - Levelling of the surface beneath the insulation using trass mortar and forming drainage slopes.
  - Installation of bentonite mats in accordance with the manufacturer's recommendations.
  - Installation of drip edges made of lead sheet, adjusted to the shape of the wall.
  - Installation of a supporting structure consisting of ribbed steel bars anchored with resin adhesives.
  - Sealing of structural penetrations using bentonite–polymer sealing compounds.
  - Rebuilding the capping with quartzite stone laid in mortar, bonded to the supporting structure, without increasing the height of the wall.



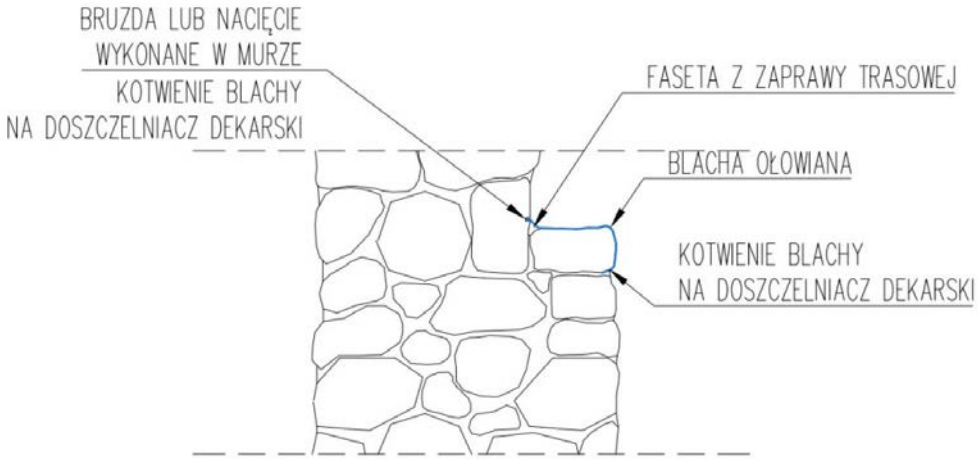
Rys. 6 Cross-section of the wall crest protection with quartzite capping and insulation layer, showing: quartzite laid in tight mortar (kwarcyt na szczelnej zaprawie), insulation mat (mata izolacyjna), lead sheet drip edge (kapinos z blachy ołowianej), reinforcing steel bar – supporting structure (pręt zbrojeniowy – konstrukcja wsporcza).



Rys. 7 Detail of the wall crest protection showing a quartzite capping masonry (nadmurowanie kwarcytowe) fixed to the existing wall (mur istniejący) by means of a steel bar supporting structure (konstrukcja wsporcza z prętów stalowych), with a minimum anchorage length of 15 cm (min. 15 cm), a minimum anchorage depth of 30 cm (min. 30 cm), and a maximum spacing of anchors of 1.2 m (max. 1.2 m)

Protection of wall steps and wall crests

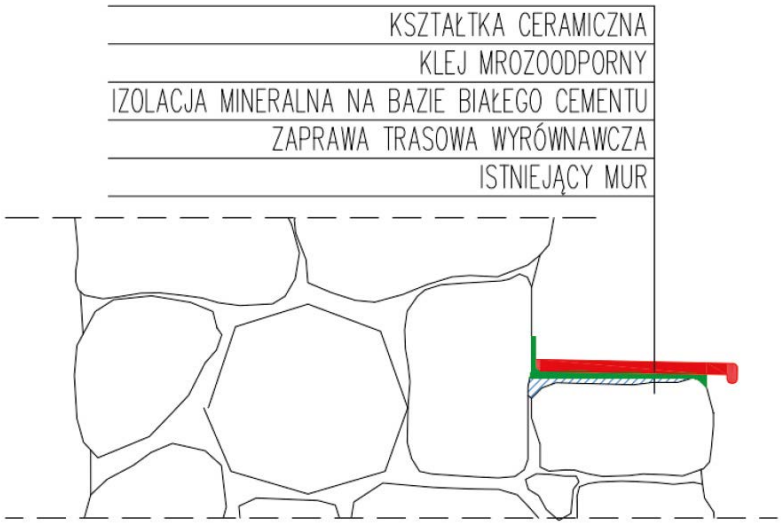
- **Protection using lead sheet.** Lead sheet protects wall steps from the accumulation of water and its penetration into the masonry structure and, due to its plasticity, can be easily adapted to the shape of the wall. The execution procedure includes:
  - Cleaning and assessment of the wall condition.
  - Levelling of the surface with trass mortar and forming a slope of at least 5%.
  - Cutting grooves in the wall above and below the protected section to accommodate the lead sheet.
  - Forming a chamfer (fillet) of trass mortar at the junction of the ledge and the wall.
  - Installation of the lead sheet, anchored in the grooves and with sealed joints.
  - Turning the lower edge of the lead sheet down over one course of stone and hammering it into the mortar joint.



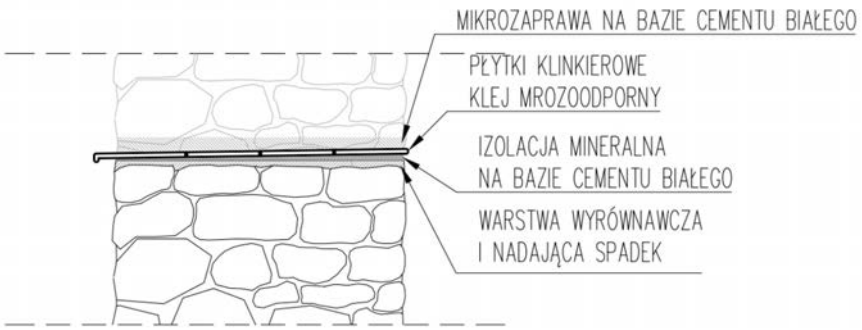
Rys. 8 Detail of wall step protection using a lead sheet (blacha ołowiana) anchored in a groove or cut formed in the masonry (bruzda lub nacięcie wykonane w murze), fixed with roofing sealant (kotwienie blachy na doszczelniacz dekarski), and finished with a chamfer made of trass mortar (faseta z zaprawy trasowej).

Protection using ceramic fittings. Execution technology:

- Assessment of the wall condition and, if necessary, carrying out repairs.
- Levelling of the surface and forming a slope of at least 2% using trass mortar.
- Installation of a mineral insulation layer, also applied to the vertical wall surfaces to a minimum height of 5 cm.
- Installation of frost-resistant ceramic fittings using frost-resistant adhesive, projecting approximately 3 cm beyond the wall face and provided with a profiled drip edge.



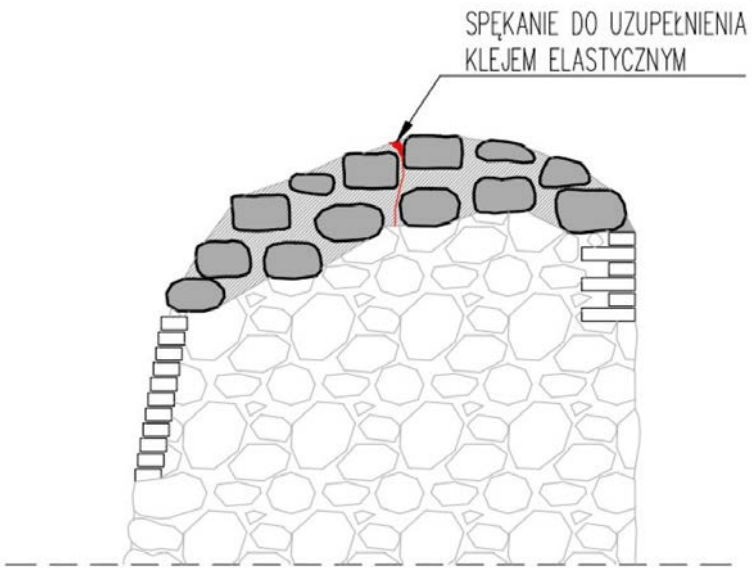
Rys. 9 Detail of wall crest protection using ceramic fittings (kształtka ceramiczna) fixed with frost-resistant adhesive (klej mrozoodporny) on a mineral insulation layer based on white cement (izolacja mineralna na bazie białego cementu), placed on a levelling trass mortar layer (zaprawa trasowa wyrównawcza) applied to the existing wall (istniejący mur)



Rys. 10 Detail of wall crest protection using clinker tiles (płytki klinkierowe) bonded with frost-resistant adhesive (klej mrozoodporny), set on a mineral insulation layer based on white cement (izolacja mineralna na bazie cementu białego), with a levelling and slope-forming layer (warstwa wyrównawcza i nadająca spadek) and finished with a micro-mortar based on white cement (mikrozaprawa na bazie cementu białego)

Repair of existing quartzite protective cappings

- Applied in cases where only the mortar bonding the stone has been damaged and complete dismantling of the capping is unjustified. Cracks are filled with a low-viscosity injection resin, applied by brush impregnation or by gravity pouring, with the process repeated several times.



Rys. 3 Detail of repair of an existing quartzite wall crest capping showing a crack intended to be filled with elastic adhesive (spękanie do uzupełnienia klejem elastycznym) in order to restore continuity and tightness of the protective layer.

6. SUMMARY

In conclusion, the Janowiec Castle remains one of the best-documented examples of permanent ruin conservation in Poland. However, its further preservation requires the implementation of an integrated programme for the protection of wall crests, encompassing both repair works and systematic technical monitoring. Only such an approach can ensure the long-term stabilisation and protection of this exceptional monument, which constitutes an important element of the region's architectural and cultural heritage.

The wall crests of the Janowiec Castle on the Vistula River, as the parts of the structure most exposed to destructive processes, require continuous conservation care. An analysis of historical and contemporary interventions indicates that, despite the intensive protective works carried out between 1976 and 1995 (including the capping of opoka masonry walls, the execution of quartzite wall crests, and structural reinforcements), the current technical condition must be assessed as unsatisfactory.

Material degradation of limestone opoka, loss of mortar, damage caused by freeze–thaw cycles, and biological growth (mosses, lichens, self-seeded vegetation) lead to a reduction in wall cohesion and a loss of structural stability. An additional problem is the lack of an effective system for draining rainwater from the wall crests, which accelerates the processes of deterioration.

A review of available protection methods—from capping and partial rebuilding, through injections and insulation, to roofing structures and the use of ceramic fittings—demonstrates that effective protection requires a comprehensive conservation programme.

Of key importance is the selection of technologies consistent with the principle of minimal intervention and material compatibility, while simultaneously ensuring durability and the legibility of the historic structure.

In the case of the Janowiec Castle, solutions already tested at the site are recommended, such as quartzite capping with insulation and roofing systems (using lead sheet or ceramic fittings). Their advantages include not only technical effectiveness but also the possibility of reusing part of the existing material, which reduces costs and supports the preservation of material authenticity. A crucial improvement is the execution of these protective measures together with the installation of an insulation layer at the interface between the existing wall and the capping masonry. This solution is intended to prevent the penetration of rainwater and meltwater into the interior of the walls..

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PROBLEMATYKA KONSERWCJI I NAPRAW KORON MURÓW ZAMKÓW W JANOWCU NAD WISŁĄ

Streszczenie

Korony murów są najbardziej narażone na destrukcyjne działanie czynników atmosferycznych i biologicznych, co w przypadku zamku w Janowcu, zbudowanego głównie z opoki wapnistej, powoduje przyspieszoną degradację. Autorzy przedstawiają rozwój metod konserwatorskich – od historycznych prób z użyciem darni czy żywic epoksydowych, przez rozwiązania techniczno-biologiczne, po współczesne techniki oparte na nadmurowaniach,

iniekcjach i izolacjach. Opisano historię zamku, od powstania w XVI wieku jako rezydencji Firlejów, przez zniszczenia wojenne i użytkowanie gospodarcze, po działania zabezpieczające prowadzone od lat 70. XX w. Podkreślono znaczenie konserwacji ruin z minimalną ingerencją w oryginalną substancję. Analiza stanu technicznego wykazała poważne uszkodzenia: erozję opoki, ubytki zapraw, korozję biologiczną, uszkodzenia mrozowe i solne, a także negatywne skutki wcześniejszych napraw wykonanych zaprawami cementowymi. Porównanie dokumentacji z lat 2010 i 2025 dowodzi postępującej degradacji oraz wzrostu zagrożeń dla stabilności murów i bezpieczeństwa zwiedzających. W części projektowej zaproponowano kompleksowe rozwiązania: przemurowania i iniekcje wzmacniające, nadmurowania kwarcytowe z izolacją, zabezpieczenia blachą ołowianą i kształtkami ceramicznymi. Rekomendowane są metody sprawdzone już w Janowcu, łączące skuteczność techniczną z zachowaniem autentyzmu i czytelności historycznej struktury. Podsumowując, autorzy wskazują na konieczność wdrożenia zintegrowanego programu konserwatorskiego, obejmującego naprawy, monitoring i systematyczną pielęgnację, aby zapewnić długoterminową ochronę tego wyjątkowego zabytku.

Słowa kluczowe: zamek w Janowcu, korony murów, konserwacja ruin, opoka wapnista, degradacja murów, zabezpieczenia murów, techniki konserwatorskie, architektura obronna, ochrona dziedzictwa, trwała ruina