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RUINS

REPORT ON THE CURRENT STATE-OF-ART ON PROTECTION, CONSERVATION AND PRESERVATION OF HISTORICAL RUINS

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1. INTRODUCTION - THE SCOPE AND STRUCTURE OF THE REPORT

"*Report on the current state-of-art on protection, conservation and preservation of medieval ruins*" is a summary of the task – Activity A.T1.1 - *Elaboration of state-of-art on protection of the ruins (based on the literature and case studies)*.

The aim of the task was to collect information, analyse, and synthesize information on the current state of knowledge in the field of conservation protection of the historic ruins. Due to the RUINS project structure, the report is to form the basis for developing further project activities. The report focuses on technical issues and their conditions, because issues related to the use and management of ruins are the subject of other reports developed as a part of the project.

The report has been prepared on the basis of a literature analysis devoted to the protection of historic ruins and information collected during study visits organized as part of the RUINS project.

According to the assumptions of the project, all teams participated in the preparation of the report. Individual teams developed national reports that were included in the preparation of this report.

The comprehensive report was developed by a project team from the Lublin University of Technology and ICOMOS Poland. Due to the nature of the issues, the team involved construction engineers and architects specializing in technical issues of protection of the historic ruins.

Due to the scope of the project and its further tasks, the assumptions regarding the nature and structure of the report were adopted. On the basis of the initial analysis of literature and the case studies, it was assumed that the development of the state of knowledge should be focused on the issues that are most important for the conservation problems of the protection of historic ruins.

With this assumption in mind, the structure of the report was adopted, which consists of the following parts:

- "Historic ruin in the scope of the conservation theory"
- "Studies of historic ruins"
- "Repairs of historic ruins"
- "National reports on the conservation of historic ruins"
- "Conclusions and recommendations"

In the part titled "Historic ruin in the scope of the conservation theory", information was presented that depicts a historic ruin from the point of view of contemporary conservation theory. Issues important to choose the form of protection of ruins are presented – the characteristics of the historic ruins as a separate typological group of monuments, the separateness of the so-called "contemporary ruin" and "historic ruin", principles of protection of historic ruins, and terminology.

In the part entitled "Studies of historic ruins", the research has been presented, which should be the basis for the assessment of the ruins technical condition and which determine the scope of conservation works. The presented scope of research is of a comprehensive nature as it covers the diagnostics of all elements and damages that are important in the historic ruins. After further development of the project, this part of the project may be a separate publication.

In the part titled "Repairs of historic ruins", selected issues related to securing the historic ruins were presented. Two key issues for the technical protection of the ruins have been presented: protection of a wall top and structural protection of walls.

In the part entitled "National reports on the conservation of historic ruins", the reports prepared by individual project participants were presented. The reports present issues recognized by the project participants as the most important and possible to elaborate due to the specificity of their qualifications.

In the part entitled "Conclusions and recommendations", the postulates regarding the directions of further works under the project were collected. The scope of issues (publications) was defined, which should, within the framework of the project, create an appropriate substantive basis for the protection and conservation of historic ruins.

It should be emphasized that some parts of the report have been developed in a way that allows them to be published. Thanks to this, it will be possible to widen the dissemination of the results collected to the report.

2. HISTORIC RUIN IN THE SCOPE OF THE CONSERVATION THEORY

The problem of protection and conservation of the historic ruins is a classic conservation issue. This can be considered because the way of dealing with ruins was among the first problems undertaken by conservators of monuments, and because it has been recognized long as dissolved. Securing the historic ruin in the form of the so-called permanent ruin follows the principles formulated by J. Ruskin or W. Morris, that is, the principles of conservators from the mid-nineteenth century.

However, while the form of a permanent ruin still does not raise objections from the point of view of conservation goals, it is increasingly often considered as unsatisfactory for other reasons. Practice shows that maintaining a permanent ruin still poses many technical problems. The costs of a conservational protection of ruins, their supervision and access to tourist traffic are significant, and as a rule they exceed income related to their access. The permanent ruin is not readable enough, and therefore not very attractive to visitors. Very often, there are also voices saying that maintaining a monument that do not have utility functions has no social justification and support.

All this makes the seemingly solved problem of maintaining historic ruins still as open. Nevertheless, from the point of view of the conservation theory there are several issues that should be presented, as they have a direct impact on the form of protection of historic ruins.

2.1 Permanent ruin as a form of securing a historic ruin

The ruins of historic buildings have been the subject of conservation activities since the mid-nineteenth century. On the basis of these activities, the conservation theory has developed a standard of actions to secure a historic ruin. The principles of keeping the object in the form of the permanent ruin can be characterized as follows.

- the ruin is preserved in a form close to that shaped by time (with minor additions) – it remains a ruin;
- supplements are limited to the minimum necessary - mainly due to technical reasons; it may be justifiable to "clarify" certain elements (e.g., reconstructing a fragment of a wall that has not been preserved at the ground level – it is underground, and the clarification is made at ground level); sometimes the solid of the object is also shown by combining individual elements;

- technical protection of walls preserved are made – a wall top and faces of walls; restorations are made of the same or foreign material;
- structural reinforcements of vertical elements are made – anchors, wreaths, stays, and foundation reinforcements; the essence of these enhancements is that they are made of materials and in a contemporary form; these elements are visible or hidden – these are doctrinal issues;
- modern additions are used in various ways – e.g., weld, metal sheet, material diversification, the purpose is to clearly indicate the authentic elements of the ruin;
- removing high greenery obscuring a ruin and greenery destroying it; displaying the elements of the ruin on the background of lawns;
- possible adjustment of the ruins for the needs of tourist traffic, in a way that does not interfere with the object: e.g., route designation, accident protection, fencing, setting of information boards, lapidarium, toilets, and tourist service points.

The presented principles of maintaining a permanent ruin are already a canon, the English school of ruin maintenance called in the literature[1]. The way of securing the ruins in many countries has been for decades in this quite obvious canon – if, of course, conservation activities were carried out on them. In this way, many ruins have been secured and still are protected. These rules were most often abandoned in places attractive and developed enough that the pressure to transform ruins into cubic objects had a justification for use and financial support. However, such activities have so far been in the minority and as a rule are not accepted by conservators. It must be emphasized clearly that from the point of view of the traditionally formulated goal of conservation – the preservation of the historically shaped form and the matter of the monument, the canon of permanent ruin should be considered as appropriate and optimal.

2.2 "Historic ruin" vs. "contemporary ruin"

From the point of view of the goals and principles of the discipline which is the conservation of monuments, two types of ruins should be distinguished; the "contemporary ruin" and "historic ruin".

"Contemporary ruin" is a ruin that was created relatively recently, most often during a unique, one-time act of destruction, e.g., war, earthquake, fire, flood,

[1] The term, e.g., in Poland, has been popularized since the 1950s. – Por. A.Gruszecki, *Konserwacja ruin w Anglii*, „Ochrona zabytków", no. 3, 1958.

construction disaster, and exceptional neglect. Many examples of historical objects can be given, which in such circumstances have become ruins in the last few decades, which of course does not mean that in the form of a ruin remained. In Poland, first of all, a lot of this type of ruins was left by the Second World War and the period of subsequent system transformations. Other circumstances of falling historic objects into ruin are fortunately relatively small.

All ruins listed – regardless of the circumstances of the uprising – are linked by the fact that the act of destruction has taken place recently. This means that in the vast majority of these facilities we have materials that document their condition immediately before destruction. In general, in countries such as Poland, for historical objects – this dependence is proportional to their historical value – various types of documentation are developed. They are accurate and reliable enough to allow the reconstruction of these objects. The possible decision to rebuild, therefore, depends on the interpretation of the conservation doctrine (operational or financial issues are omitted here).

Interpretation of the conservation doctrine should also take into account the second factor related to the act of ruining the object, which was not long in time. A very important feature of this type of ruins is that they are present in common memory (in the memory of living generations) as objects, not as ruins. This was the case with the Polish historical cities destroyed during the war, so it was with the destroyed bridge in Mostar, the monumental statues of Buddha in Afghanistan blown up by the Taliban, or the historical city of Bam in Iran, which was destroyed by the earthquake.

So, the specifics of the so-called "contemporary ruins " are determined by two features; the form of the object is known before destruction, and in the memory of living generations, the image of the object is preserved, not the ruin. These characteristics fundamentally distinguish this type of ruin from the so-called "historic ruins" and at the same time indicate the direction of action. Monuments ruined today are simply rebuilt. In conservation, there is a long-standing conservation trend, which does not accept any reconstruction, nevertheless, most experts agree in this case to such activities. The discussions are related to the limits that can be taken in the reconstruction of craft details, the scope of modernization or the right to modern additions. As a result, today's ruined monuments remain in ruin in exceptional circumstances. The modern ruins are such an exception, which were left to commemorate the circumstances of destruction. For example, the ruins of churches in Berlin or Dresden were left after the destruction of World War II. In these special cases the symbolism of ruins became more important than the historical value of the previously existing objects. This symbolism is ambiguous and prone to different interpretations. For example, leaving a ruined church in the rebuilt Dresden for some was a reminder and a warning against German militarism, for others it was an objection to the post-war division of Germany. Regardless of interpretation, such ruins from the conservation point of view are treated as the second group – the so-called "historic ruins".

A part of the ruined military objects should also formally belong to the group of contemporary ruins. The problem relates generally to defense works of the 19th and 20th centuries; they were primarily of military value in recent wars and therefore they were ruined during these wars. This group of objects is very specific, nevertheless the manner of their preservation is also close to the rules of preserving historic ruins.

The second group is called as the "historic ruins". Of course, this is not a homogeneous group – several types of these ruins can be distinguished, nevertheless common features can be indicated that connect and define a whole group of monuments called as the historic ruins.

The historic ruins were shaped in the natural process of destruction (violent events could have been the beginning); this process could have a long-lasting nature, it happened outside the memory of living generations – it could last for centuries (medieval monuments), millennia (antique ruins), many millennia (megalithic ruins).

The form of historic ruins is similar – limited to elements of the basement, foundations, individual fragments of structural walls – only fragments made of the most durable materials (brick or stone) survived; horizontal elements – wooden (roofs and ceilings) and masonry (ceilings, vaults, lintels), no longer exist.

Due to the extent damage, the historic ruins cannot fulfill modern utility functions; its possible reconstruction would require huge costs, which could be comparable or exceeding the so-called replacement value.

In the case of historic ruins, neither archaeological nor architectural research provide scientifically reliable information that allows to recreate the shape and interior of the object – the projection of the object is clear at most. Most often, there is also no reliable iconography, which would allow to recreate the historical appearance of the object.

Features differentiating „contemporary ruins” and „historic ruins”

Criteria	Contemporary ruin	Historic ruin
Period of destruction	In memory of living generations ruin was recalled as an object	The historic object has been ruined beyond the memory of living generations
Cause of destruction	Exceptional circumstances /war, fire, flood, earthquake/	Longstanding, natural process /could be preceded by the violent circumstances/
Information regarding original building	Object is documented	Documentation is not sufficient
Type of building	Not important /mainly public buildings/	Mainly military and religious building
Technical condition /state of destruction and completeness/	Various fragments of building still exist /walls, stairs, roofs, architectural details, etc./	Only fragments of main walls still exist
Period of creation	Not important	Century at least /mainly medieval monuments/

The presented characteristics do not mean that all historic ruins are the same and that a uniform scheme of a conservation work can be applied to them. The characteristics and number of ruins in particular countries or cultural circles depend on many local factors, such as the history of economic, cultural, social, and military development or the history of the area in question. Therefore, several types of ruins can be distinguished in Europe. Due to common features – the period of creation, technical characteristics, form of survival, scope of documentation and development possibilities, the following types of the historic ruins can be distinguished[2]:

- megalithic ruins
- ancient ruins
- medieval ruins
- ruins of modern military facilities

2.3 Limitations characterizing historic ruins

The negative features characterizing a historic ruin are also significant for defining the principles and forms of preservation of these type of building. Negative features are important because they significantly affect the reception and use of the ruins. Therefore, in practice, each concept of dealing with ruin is aimed at reducing or even completely eliminating its negative features.

However, it must be assumed that the conservation activities carried out at the historic ruins are primarily intended to preserve the form of the ruin. Therefore, only the negative traits characterizing the ruin can be removed to a certain extent.

Of course, from the post-conservation point of view, it is most desirable to completely eliminate the negative features of the ruin. From this perspective it is understandable, logical, and justified. In practice, however, it would require the transformation of the ruin into a complete object.

Of course, there is no doubt that a complete monument has more value than its ruin. And this is the argument that the advocates of the reconstruction of ruins often invoke. However, such a statement is false. There is no choice between a historic ruin of the object and a rebuilt complete historic building. The real alternative is a historic ruin or a modern building with a historical form that incorporates historic elements. The construction of such an object irreversibly destroys authentic historical elements.

However, the construction of an object stylized on a ruin can be questioned only on the level of a conservation argumentation. This requires above all to show that the historic ruin in this form – despite its negative features – has value. It means that the confrontation with the values represented by the complete object is inevitable

[2] In addition, a group of "artificial historic ruins" can be distinguished, which means ruins built in the same form. These ruins were created in the nineteenth-century romantic landscape parks. They were assigned significance in ideological programs of parks, but their function was limited to aesthetic and scenic reasons. Currently, it is a small group of objects which maintenance should be carried out in accordance with the canon of securing the permanent ruin.

(ruin rebuilt). This confrontation requires weakening/compensating for the negative features of the ruin.

Activities complementing the drawbacks of historic ruins

Feature analysed	Characteristic	Action
Completeness/integrity of the object /as a building with specific rules of creation and constituent elements/	- ruin is an incomplete object	- to clarify the completeness of the object with other forms /non-building/
Technical condition of an object /as a construction with a specific technical condition/	- ruin is in the process of destruction	- to stop the process of destruction /the standard of so-called permanent ruin/
The functionality of the building/ as a building capable of performing certain utility functions/	- ruin is very functionally limited /cannot fulfil many utility functions/	- introduce many complementary functions, lack of direct volume-based functions
Readability and communication of the object /as an object realizing the message/ communication/ symbolism/	- the ruin is unreadable, incomprehensible, incomplete	- to clarify/ interpret/ present transmission of the object by many non-building forms

In practice, this leads to the conclusion that the historic ruin conservation program must take into account two opposing goals – protecting the form of the ruin while neutralizing/compensating for the negative traits that are characterized by the ruin.

Contrary to appearances, it is possible. However, it requires a combination of two elements. The protection program should include the maintenance of the ruins (conservatory/technical protection of the building structure) and a number of supporting activities (management and use).

In practice, conservation concepts of the protection of historic ruins consist in supplementing deficits resulting from their negative traits.

It should be emphasized that this juxtaposition reveals the limited scope of activities achieved thanks to the permanent settlement of the ruin. It is a set of activities primarily of a technical nature, thus stopping the process of building destruction.

Meanwhile, the ruin protection program, in order to be competitive to its reconstruction, must also include activities in the other three areas.

2.4 Terminology of the conservation activities on damaged objects

Another important issue established within the conservation theory is the terminology. There is no universal dictionary of conservation concepts in heritage protection issues. Dozens of terms most commonly used in heritage protection do not have precisely defined meanings, i.e., the semantic fields. They are used intuitively, and the lack of precision is deepened by the fact that in various doctrinal documents the same concepts are defined in very different ways.

Meanwhile, it is possible and necessary to define a few concepts that are reflecting significant differences in the handling of damaged historical objects.

For the characteristics of historic objects perceived as material carriers of various values, the key features are authenticity and integrity. Therefore, the terms describing technical actions regarding damaged historic objects should refer to a historic/authentic matter.

From this point of view, four types of conditions and actions can be distinguished.

The terms presented describe other ranges of action resulting also from different circumstances in which the destroyed monument is. At the same time they create a complementary system.

Application of these terms allows to name and differentiate specific situations in which damaged objects are. The adoption and consistent application of the specified terms is therefore another element that, as part of the conservation theory, can help in ordering the management of historic ruins.

Activities concerning objects destroyed.

Activity	Characteristics	Examples
Anastylosis	-re-composition of authentic fragments of historic object -minor contemporary additions resulting from static conditions	-ancient objects built from large stone elements
Restitution	-rebuilding of historic buildings with use of many dispersed (original) elements -contemporary fabric dominates over the historic one; historic form is recreated	Royal Castle in Warszawa
Rebuilding	-recreation of recently destroyed object in exceptional circumstances -the historical form is recreated based on reliable documentation	-Frauenkiche Drezden
Reconstruction	-recreation of object destroyed in far past -the form of recreated object is hypothetical /lack of information/	-reconstruction of medieval castles

3. RESEARCH ON HISTORIC RUINS

3.1. Stocktaking measurements

The measuring-drawing stocktaking is the most popular, and at the same time the basic form of documentation of monuments. Due to the lack of precise information about objects which are recognized as ruins, it is necessary to prepare an accurate stocktaking. There is a need to elaborate an analysis, which would consider theirs specificity and condition of maintenance. Performing stocktaking documentation is an action connected with conservation, which should be prepared before various tests and projects. This is also extremely important because of the possibility of monitoring the facility. Accurate documentation and stocktaking measurements of objects are basis for any conservation activities.

The stocktaking consists mainly in preparing measuring drawings, as well as a description of the current object maintenance or his part. Its aim is to get to know the monument. Regardless of the adopted method of the stocktaking of facility, it starts with carrying out the vision in the field. Only after precise interview the stocktaking measurements could be performed. This analysis should be elaborated in a specific way. It should take into account all visible deformations, transformations, scratches, cracks, visible details, and sometimes transformations of an object over a period of time. Accurate mapping of the real spatial layout and determination of the technical and functional structure of objects or its parts are the purposes of stocktaking. Based on various measurements, an architectural documentation of this facilities is being prepared.

The stocktaking constitutes an initial material to execute any works on the object, it enables carrying out any research and ruins analyses. The stocktaking fulfils a function of condition registering of an object at a given time. The stocktaking measurements are a basis to draw up construction and implementation projects, and at a later time for calculation of construction and conservation works. The effects of the stocktaking works are presented in descriptive, graphic, and photographic forms.

The stocktaking is required, among other for:

- extension of an object,
- superstructure of an object,
- renovation of a building,
- dismantling of a historic structure,
- assessment of a technical condition.

Scale of drawings

The stocktaking of facilities should be performed in a proper scale, in case of masonry buildings usually in 1:50. The scope of the stocktaking is not clearly defined and largely depends on purpose, which it is drawn up for. If the drawings would be attached only to the cards, they should be schematic and take into account only basic dimensions. This studies could be prepared even in a 1:100 scale due to the low degree of accuracy. The measuring-drawing documentation made to research and conservations needs should be drawn up more precisely. The use of a 1:50 scale results in greater accuracy of the drawing. Both cross-sections and facades should be detailed, which is difficult when using the 1:100 scale. Details should be drawn up in a scale which enables to show every elements of its content in a precise way while maintaining a high readability of the drawing, therefore the appropriate scale is 1:1, 1:10 eventually 1:20. It is therefore stated that the more extensive purpose of research, the more detailed the documentation should be.

The scope of the stocktaking

It should be also remembered that an integral part of the measurement and drawing documentation is the descriptive part, which consists of a description of the measurement methods and the characteristics of the object. It is also necessary to make the photographic documentation.

The scope of the stocktaking documentation required may include:

- a situational drawing,
- plans of all storeys,
- vertical sections,
- facades drawings,
- drawings of historic details,
- photographic documentation,
- technical description, taking into account the location of the facility, its type and nature, the number of storeys, the height of the building and its surface,
- description of materials from which individual building elements were made.

Depending on the subsequent destiny of the stocktaking, the issue of its implementation will also be presented in a completely different way. Due to the fact that the objects in the ruin are so diverse, it is not possible to unambiguously determine the number of drawings which are necessary to make. Typically, the spatial layout of the object requires several vertical sections. Drawings must take into account all historic details, which should be marked both on projections and on more accurate drawings in a correspondingly larger scale.

Norms and technical guidelines applicable in the scope of the stocktaking

Regarding the provisions concerning the stocktaking, there are many standards related to the preparation of the construction drawings and the rooms size measurements, but they will not be discussed due to their high level of detail. Due to the fact that objects in ruin are atypical objects, it is not possible to apply all applicable standards simultaneously. These standards in the case of ruins will not find such a great use, because of their specificity.

Objects in ruin are so unique that we are not able to even refer to the level of sampling. The horizontal cutting plane will be determined on the basis of analysing the object and selecting the most individual features. It may be that the measurement made at the level of 1 m will not work, because there will be no important elements or holes. Then it will be necessary to perform it on another, perhaps a lot higher level.

As for the application of standards, it really depends on the specificity of the building and its state of preservation. Standards only appear as guidelines for development, but it is not possible to use them in every situation. They only set certain standards. Therefore, in many cases derogations will be necessary.

The issues realted to the measuring-drawing stocktaking

Usually, many problems arise during the stocktaking creation. The main and most problematic issue that arises when making the stocktaking is the lack of its standardization. Incorrect recognition of the object, a poor measurement method or inadequate drawing cause many errors and shortcomings.

The basic problem of a manual measurement is the course of the measurement process, because the measurements collected cannot fully reflect the actual structure. The reason for this is not taking into account the comparison levels, diagonals, and polygons. This results in a schematic approach to drawings without taking distortions into account. A misplaced projection will cause errors in subsequent drawings. The documentation will bear many errors and distorted dimensions. The dimensions interpolation is also incorrect.

A frequent mistake that is made when developing measurement and drawing documentation of the facility is failure to comply with standards, especially those that define graphic signs appearing in architectural drawings. In many cases, it is also forgotten that the text part and photographic documentation is an integral part of the drawing documentation.

Most of the errors that occur during the creation of the stocktaking result to a large extent from the fact that there is no regulation regarding the execution of the stocktaking documentation. Quite the opposite than in the case of creating the project documentation, conservation and restoration studies, architectural and conservation studies, or conservation supervision. The measuring-drawing stocktaking is not included in the quality control. This situation means that the submitted documentation may be incomplete or may have many shortcomings and measurement deficiencies.

3.1.1. Traditional measuring techniques

In the process of the object documentation and the execution of its stocktaking, the methodology and measurement technique is extremely important. Depending on the type of the facility, the scope of the stocktaking and the implementation options, these methods will differ from each other. The main techniques of performing the stocktaking include:

- traditional method,
- geodetic method,
- photogrammetry,
- laser scanning.

Traditional method

Traditional manual measurement belongs to the method of direct measurements. It is mainly used to make the stocktaking of simple buildings and architectural details, due to the increasingly high requirements for the accuracy of measurements. It is often a supplementary material to the geodetic measurement method.

For making traditional measurements, tapes, scoops, and laser rangefinders are used. This method is extremely time-consuming and requires a lot of work, and what is important, it is not always possible to accurately measure all elements due to their unavailability. It is also very possible to make a measuring error by the measuring person. However, a great advantage of the traditional measurement method is the possibility of making a detailed analysis of the construction structure being developed.

Photo 1 Measurements of the Donjon facade on the Kłodzko Fortress using the traditional method.

First, a field vision is made, and then a measurement sketch is made. For the measurements of the horizontal projections, the lengths of all interior walls and their elements, including details, are measured. In order to avoid errors in measurements, the so-called "string record" should be used, that is, successively read dimensions from the characteristic points on the wall. When dealing with long walls, measurements should be made twice. All measurements should be taken at one height. It should also always be remembered to give the floor level relative to the reference point, which is usually the level of the ground floor. The thickness of the walls should be measured in places where the full dimension can be obtained directly or, alternatively, it should be made in sections.

When making measurements of the horizontal projections, dimensions should be given in the light of all openings and recesses, the height of window sills, vaults; door and window openings should be measured both in the light of the opening and the frame. The drawing of the staircase is made in the appropriate plane of the horizontal section of the room. In the direct stocktaking method, it is extremely important to coordinate the projections of all stories with the use of communication divisions and openings.

When making measurements for vertical sections, it should be remembered that the cross-sectional dimensions, i.e., the thickness, should only be given if they have been measured directly, not on the basis of calculations. All height measurements should be given relative to the reference point adopted for the given object or its fragment.

Facade measurements are made on the basis of their projections and designated heights of characteristic points. As well as horizontal and vertical cross-sections, the measurements should be given in relation to the reference level. For the facade measurements, it is necessary to proceed only after measuring all projections and cross-sections. Thanks to this, information on which elements should be added can be get. When making facade stocktaking drawings, particular attention should be paid to various types of damage, losses, cracks, and secondary materials. They should be marked at place of their occurrence and be properly described. All places or spaces that are not available should be designated and described in the drawings. Elements located at significant heights that are not within the range of direct measurements must be marked and given in the way in which they were drawn.

3.1.2. Geodetic method

There are two geodetic methods for performing the stocktaking measurements. One of them is a method using a leveler, in the other – a tachymeter.

The leveler is a geodetic instrument that allows measuring the height difference between terrain ordinates.

Another instrument used by the land surveyor in the field is the electronic tachymeter. In recent times, instruments are used for distance measurement without the use of a mirror. They allow to determine the geometry of the object and are useful for measuring the photogrammetric matrix, so that the reflectorless tachymeter is very suitable for the architectural stocktaking. The range of distance measurement is several hundred meters.

The stocktaking using a tachymeter is based on measuring distances and angles. The distance is determined on the basis of the coordinates increments between the position of the measuring instrument and the point measured. The measurement of the length of the section to the designated point is collected thanks to the laser rangefinder mounted in the tachymeter. This device allows to measure strictly selected points, which will determine the characteristic places on the object. Measurements with a tachymeter will work to create projections, cross-sections, and simple facades. Accurate measurement of details with this device is extremely time-consuming, so it would be good to combine two methods, both geodetic and manual measurements. Thanks to the tachymeter the geometry of the walls is able to obtain, while measuring with a ruler or a range finder it is possible to measure more accurate elements.

When using a tachymeter together with the appropriate software, it significantly speeds up the work and ensures high accuracy of measurements. Of course, it is possible to perform a full stocktaking using a tachymeter, but it requires a huge amount of time spent on the site. Drawings are then created directly on the spot in a CAD program, in the form of traditional projections and cross-sections. However, before starting the work, the cutting planes must be precisely defined. Thanks to the fact that the documentation is created on an ongoing basis, it is possible to immediately correct any errors.

3.1.3. Traditional, spherical, and photography using the drone

Photographic documentation is an indispensable element for conducting a detailed analysis of the facility, determining its technical condition as well as for archival purposes and documenting the current state of the object. It is a supplementary material for a graphic material. The pictures should be taken in the best possible resolution and quality. Photographic documentation should also be made using a photogrammetric stocktaking, as a supplement to the measurement material.

Photographic documentation should consist of:

- a list of photos,
- a list of pictures numbered and described in detail,
- a graphic presentation of the plan of photographic positions.

The photo catalog should include photographs made in such a way as to show the general characteristics of the shape, its location in space, all elevations and details. The order of photos should ensure easy orientation in the facility and allow quick location of the photo in the documentation.

There are three basic photo sets:

I – photographs showing the object with the general context, showing the general characteristics of the shape, its embedding in space, full elevations. Full frames, without cutting the object,

II – photographs showing the elements of the object, i.e., the entire window or door element,

III – photographs showing close-ups related to the detail, i.e., cracks, discolorations, damage, etc.

Types of the photographic documentation:

- traditional photography,
- spherical photography,
- photos made by a drone.

Traditional photography

The photographs should be made in a similar way to the orthogonal way, in order to avoid distortions of the object. In certain cases, when there is a need to make photographic documentation and display individual building elements, side or diagonal pictures can be taken. Photographs of details should contain a clear comparative scale.

Photo 1
A photograph depicting the front of the Janowiec Castle

Photographic documentation should present the whole object and its parts, details, characteristic elements, elevations, and elements of an architectural decor. Photographs should be taken from characteristic viewpoints to enable the display of the whole object or its fragments. It is also necessary to take pictures as perpendicular to the façade as possible, pictures of characteristic elements, openings, materials, and damages of the wall.

Spherical photography

It is a modern type of photography that gives the opportunity to cover the whole environment around the camera. The view range is 360^0 horizontally and 180^0 vertically, which gives the opportunity to rotate around own axis and look down and straight up. The spherical photography is not limited by the so-called frame, compared to traditional static photography, which only shows a slice of reality.

To make a spherical panorama a panoramic camera is necessary, the 360^0 camera, or fragments of images can be combined using the appropriate software. Individual photographs should be made in such a way that each subsequent photo overlap in about 20-40%. Thanks to this, control points are created allowing for the connection of frames.

Photo 2 Photograph taken from the 360^0 camera, flat image view.

A normal photo taken from the 360^0 camera, viewed without the use of appropriate software, gives us a flat image. The picture shows a striped view. However, only computer programs allow to get the effect of looking around freely. High resolution of the pictures allows to zooming. As you zoom in, the image flattens.

This type of documentation is an ideal complementary stocktaking material that also allows to create a virtual walk around the object.

Photos made by a drone

Unmanned aerial vehicles, or drones, have enormous potential. Currently, thanks to their use, it is possible to perform many works that are unattainable using traditional methods. In the case of stocktaking of objects in ruin, this technology allows to reach places that are impossible to photograph using traditional photographic documentation methods. The drones give the possibility of covering the entire object from the top, so when making measurements it is helpful in determining the exact shape of the ruin.

3.1.4. Photogrammetry

Photogrammetry is a measurement to determine the exact geometry of a given object based on the photogrammetric photos. This technique is particularly helpful when making facade plans. It allows a faster drawing of the surface, and in the case of façades allows to give up additional auxiliaries, such as scaffolding, hydraulic lifts, etc. Photogrammetry is primarily suitable for recording even and decorated surfaces, which makes its use particularly useful in the case of accurate drawing stocktaking of brick and stone architecture.

Thanks to a high-resolution digital photography and user-friendly software, photogrammetry can now also be used by non-professionals in this field. In the case of smooth brick facades, this method has the advantage over others that all single bricks can be drawn from the pictures without additional measurements. In this way, it is possible to present not only the characteristic bonding of bricks, but also any change in the wall (e.g., joints or secondary bricked holes) which is of decisive importance for the architectural research. The elements protruding from the plane or located deeper should be measured beforehand with the tachymeter, as well as the adjustment points (photo points) necessary for the photogrammetry. Drawings are usually made using computer programs, if possible, directly next to the object, so as to be able to compare drawings with the original.

Precise drawings of facades made in this technology can be used in further research as a basis for the implementation of the chronological stratification, and during the conservation and restoration work they can be used for a damaged area stocktaking, and after performing the works to apply their scope.

Photogrammetry can be used not only for the presentation of facades, but also for all smooth surfaces with a large number of transformations, e.g., the face of the building walls in the ruin. Pictures can be taken before and after the conservation and restoration works. They can be left as photographic images, but essentially redrawing the photogrammetric photographs is beneficial for an architectural research, as it forces a very detailed analysis of the object's surface. In addition, converting photos into drawings is time-consuming.

The stocktaking made in the photogrammetry technique can fulfill two functions:

- they can function as plans, because they are made according to the scale,
- they can be used as the photographic documentation when they are left in the form of photographs.

The images have a very high resolution and reflect all the details, and in the CAD file in which they are inserted, all the dimensions can be get.

In many cases, even though the wall surfaces are deformed, damaged, and repaired many times, a lot of original material is kept on the faces, the condition of which allows obtaining reliable information about the object at the moment of its erection. Photogrammetry of walls can be used in architectural studies as a basis for the reconstruction of the original building.

Stages of work during photogrammetry of objects remaining in the form of the permanent ruin

- Preparatory work

Cleaning walls of weeds and shrubs and revealing parts of walls covered with earth.

- Marking of walls

It is necessary to establish on the surface documented a regular square grid for a later computer correction of optics errors. To define the grid of points the masonry cords, tapes, risers, level lines and levelers are used.

The photopoint -- a terrain point uniquely defined by the situation and altitude, with coordinates obtained from the direct geodetic measurement or GPS satellite measurement, having its equivalent in the photographic image of the photograph.

- Measurement of points

The geodetic survey of photopoints is performed with an electronic tachymeter, recording their coordinates in an internal database, which are then transmitted to a computer.

Then, computer-processed points connected with straight lines create a scheme of walls in the form of a grid of squares.

- Photography
    - High quality digital cameras are used to photograph the walls.
    - Each square of grid of points was photographed separately.
    - To avoid perspective error, pictures should be taken in a perpendicular plane.
    - The intensity of the light affects the contrast of the pictures, which is clearly visible when combining them, so they should be performed at similar light intensity.

- Processing of photos

Straightening the perspective and contouring the walls. Bringing dimensions distorted by photographs to the actual dimensions observed in the field; combining photos.

- Development of results

A high-altitude grid is applied to the previously developed photos, then individual images are combined to create all the facades, finally all the drawings are described.

3.1.5. 3D scanning

The laser scanning is a non-contact method of measurement, which is, from a technical point of view, the most accurate way to make the stocktaking measurements. The operating principle of the scanning device is based on the pulse laser detection technology reflected from the object. The laser beam sent by the scanner is reflected from the point, during the return the beam "transmits" to the photodiode information about the reflection time, which allows to determine the distance of the element. Thanks to this, the device saves the XYZ coordinates of each single point creating a spatial set.

Photo 3 The Leica C10 scanner during field work at the Castle in Janowiec.

By visualizing data in one system we get a cloud of points, which in effect is a digital representation of the object covered by the stocktaking. Measurement of many points and their mutual spatial relations is possible thanks to the scanner's rotations around the axis directed perpendicular to the base plane and simultaneous rotation of the head around the parallel axis.

Additional information provided by the laser is the intensity of the reflection of light, which allows for differentiation of elements and surfaces in the object to be measured. Very helpful when developing the cloud of points is the ability to take photos by the scanning devices. Photo processing processors and XYZ coordinates assign the points an RGB value, giving the cloud a realistic texture.

Fig. 1 The cloud of points, which was created as a result of the preparation of spatial data obtained from the Leica C10 scanner.

Measurements with a laser scanner allow to obtain many times more data in a much smaller time intervals than measurements using traditional methods. The stocktaking developed using the 3D scanning allows to create an accurate and detailed study, which is of great importance when working on historic buildings.

The large laser range, depending on the model, enables efficient measurement of large-scale objects. This is a significant advantage when making a stocktaking of large assumptions or hard-to-reach ones due to their location and development area. The density of points acquired facilitates detailed mapping of the structure of walls and the geometry of spatial elements. The creation of the cloud of points for the whole object is possible thanks to combining individual sets using defined discs placed in the field or common points determined during processing with dedicated computer programs.

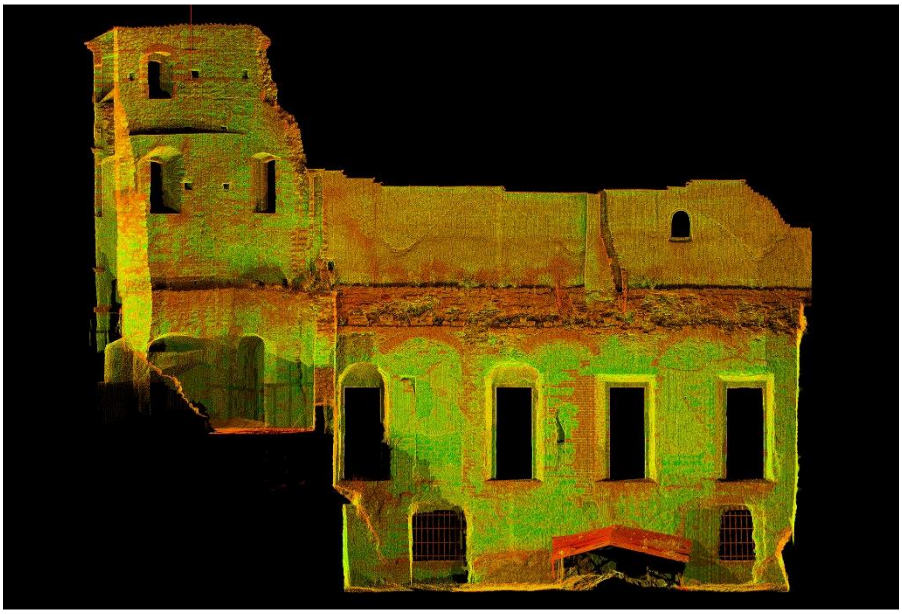

Fig. 2 Image of the southern wall of the courtyard obtained from the cloud of points.

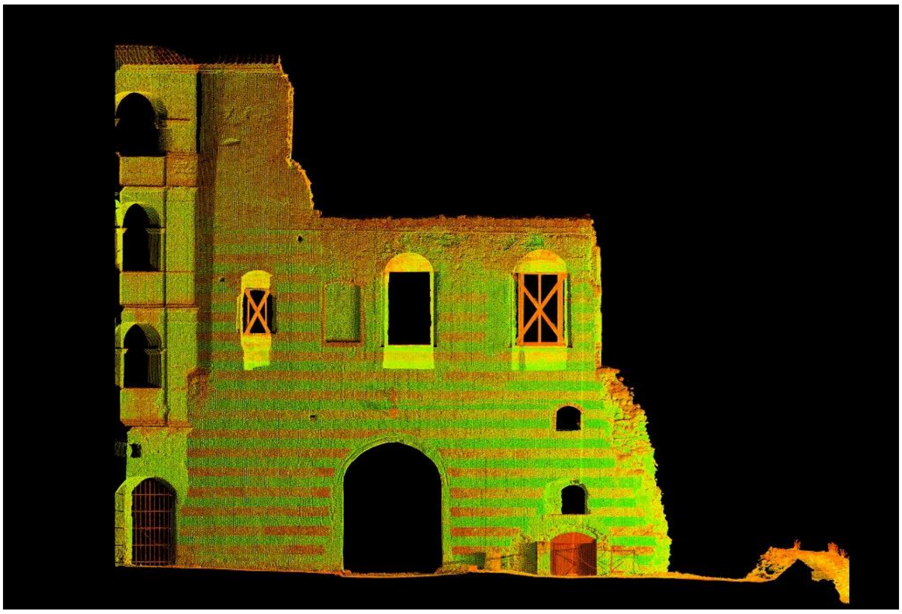

Fig. 3 Image of the eastern wall of the courtyard obtained from the cloud of points.

Analogously to the other stocktaking methods, the material obtained with a laser scanner must be prepared and presented in the form of technical drawings. However, unlike manual measurements, the probability of error when mapping the thickness of building partitions and their geometry is close to zero.

In the case of some of the complex layouts of the building or its elements, such as underground storeys or structures covered with a thick layer of a ground, the measurements come down to the use of several devices that allow the actual parameters to be mapped. The result is an extension of the data acquisition process and a greater probability of making a mistake. The main advantage of using laser scanners is the ratio of working time to achieved accuracy and accuracy of the mapping of important object parameters.

3.1.6. Literature of the chapter

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3.2. In situ testing of materials and structural elements

When conducting diagnostics of structural elements, all factors influencing it should be taken into account. Undoubtedly one of these factors is the ground substrate. Changes in the placement of buildings often result in damage to various building elements. Without recognizing the land itself, it is impossible to take preventive and corrective actions in the objects of historic ruins. To understand this problem at the very beginning, the specificity of the land is needed to know.

The ground can be divided into four basic groups: natural soils, volcanic soils, organic, and anthropogenic soils (i.e., packed soils, created as a result of human activity). Natural and volcanic soils are the most advantageous for the foundation. The remaining groups of soils are of limited capacity or completely non-bearing. The vast majority of objects are set in soils from the first two groups. In the case of organic soils, the foundation was carried out with piles, while land associated with human activities was practically nonexistent.

The soils are characterized by parameters. On the basis of these parameters, the usefulness of the land in further design and expert departments is determined. The basic parameters of the soil are: grain size, degree of compaction or plasticity, and humidity. It is also important to check the level of the groundwater. Only when knowing these basic parameters, the substrate can be characterized and try to determine its load capacity. In order to determine the ground parameters, a number of geological and engineering documentation is performed. All these documentation are the basis for the development of necessary projects directly related to works on the site.

The most commonly conducted research to determine soil and water conditions are:

- drilling in the ground and determining the basic geotechnical parameters along with the groundwater level,
- conducting dynamic sondage,
- a georadar research.

3.2.1. Examination of physical features of structural elements

In order to determine the technical condition, load-bearing capacity and strength of structural elements, a number of tests must be carried out. Based on them, it will be possible to determine the parameters determining the condition of the structure itself. The research is divided into two main groups: the indirect research and direct research.

The indirect tests are a type of research in which the determination of the desired parameters is based on the dependence of these parameters on other material parameters (e.g., determination of the compressive strength of material based on surface hardness tested by the sclerometric method).

The direct tests are tests in which the parameter sought is immediately determined (e.g., determination of the compressive strength by compression of a sample on a hydraulic press).

In addition, the tests are divided into in situ tests and laboratory tests.

The inn situ tests are tests that are carried out on the site and the result is known already at the time of the study.

The laboratory tests require the collection of a laboratory sample and determination of parameters on a laboratory equipment.

In order to determine the bearing capacity of structural elements, computer models and numerical analyzes are also used. The use of appropriate calculation algorithms gives the possibility to estimate the strength of structural elements. In order to make such a model, however, the material parameters of the construction material must be known firstly.

Endoscopic examination

The inspection testing using an endoscopic camera is a completely non-destructive examination. The test may be quasi-destructive in the case of performing a test hole to which the camera will be introduced.

The endoscopic examination consists in an inspection of hard to reach places. Depending on the endoscope used, the diameter of the camera is from 5 to even 30 mm. The camera is mounted at the end of the flexible cable. The cable length varies depending on the type of camera. Thanks to the considerable flexibility and length of the cable, it is possible to place the camera with backlight in both hard to reach places and the material structure. The whole picture from the camera appears on a regular basis on the LCD display mounted on the handle. In most cameras, it is possible to record an image and take a picture. In order to increase the precision of tests, it is recommended to use cameras with high resolutions.

Thanks to the inspection tests, the following can be determined:

- ✓ what is located in hard-to-reach places that cannot be inspected without making an inspection hole firstly,
- ✓ system of partition layers – by making a test hole on the whole thickness of the partition, it is possible to record on a regular basis changing layers of materials when inserting or removing a flexible cable with a camera,
- ✓ the type of materials used.
- ✓ material homogeneity,
- ✓ internal defects of materials – in the case of suspected damage to the internal structure of the material, after the test hole is made, it is possible to inspect the fragment in the structure.

Fig. 4 The endoscopic camera with description (*source: http://www.pay.pl/x/m/890LCD_BOX/opis_kamera.jpg*)

Ultrasonic examination

The basic device for performing these tests is the ultrasonic flaw detector – a type of device that is used to determine the properties by measuring the velocity of propagation the ultrasonic wave in the material. Ultrasounds with frequencies such as 24 kHz, 37 kHz, 54 kHz (as typical), 82 kHz, and 150 kHz are used during the tests.

The test is a specialist study. The technology of the study is varied and depends on the purpose of the study. Different test frequency and location of the test probes give the possibility to determine other parameters of the material tested.

Thanks to the ultrasonic testing, the following can be determined:

- ✓ density of the material tested,
- ✓ homogeneity of the partition tested,

- ✓ the geometry of the partition tested (determining the thickness of the partition with one-sided access),
- ✓ material defects (with their location and size).

Photo 4 Ultrasonic testing equipment

Hammer test

Similarly to the ultrasonic test, the method is based on the phenomenon of propagation of acoustic waves in the elements tested, with the difference that they are excited in a mechanical way. The method of defects detecting is based on the echo method (waves reflected from defects in the material structure are registered and processed).

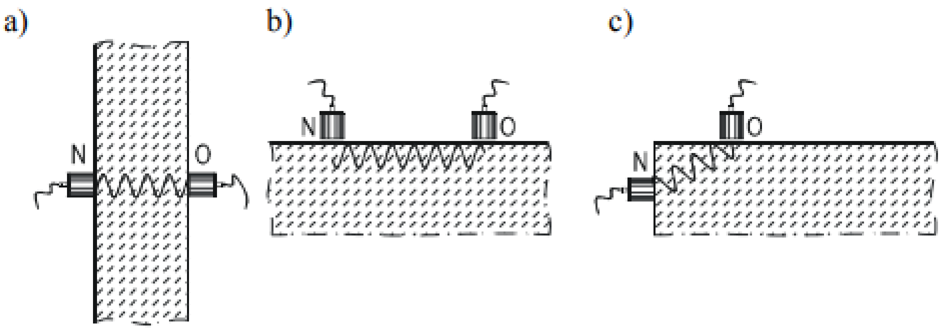


Fig. 5 Scheme of measurements performing and distribution of probes 0

Mechanical excitations are obtained by hitting a small steel ball in the surface of the element tested. The impact generates acoustic waves. These waves propagate within the material structure and are reflected by internal defects or its external surface. Displacements of the element caused by the return of reflected waves are recorded by a piezoelectric sensor in close proximity to the inductor. The obtained values of displacements as a function of time are transformed to the frequency spectrum and presented in the form of a graph. Multiple reflections of vibrations from the surface and defects lead to a vibration amplitude that can be identified in the frequency spectrum graph. This graph changes if there are any disturbances in the structure of the element and provide information about their location.

The test diagram is shown below. The waves reflected as a result of defects in the material are processed in a computer software and then presented in the form of a vibration diagram and a spectrum of vibrations. These two charts are the basis for further analysis.

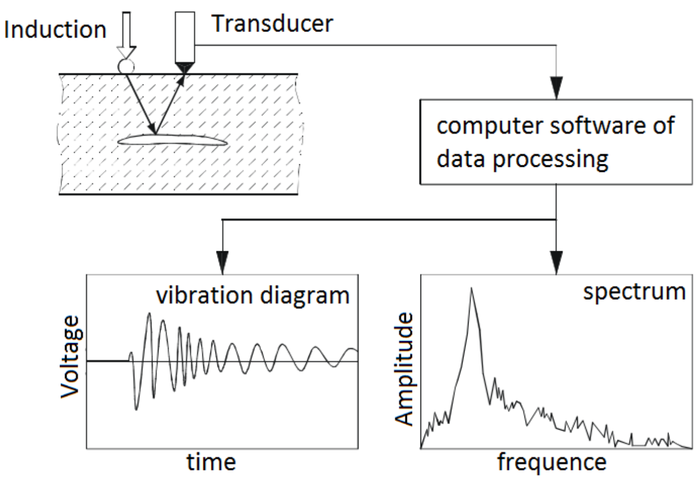


Fig. 6 Scheme of the test 0

Thanks to hammer tests, the following can be determined:

- ✓ cracks, delamination or air voids in the material,
- ✓ homogeneity of the partition tested,
- ✓ the geometry of the partition tested (determining the thickness of the partition with one-sided access),
- ✓ material defects (with their location and size).

Fig. 7 Hammer test set (*source: http://www.impact-echo.com/Impact-Echo/images/wssetup.jpg*)

Electromagnetic examination

The device used in this study is the ferroscan (femetr). The device is mainly intended for detecting reinforcement in reinforced concrete elements, but it is also used in monuments.

Fig. 8 Femetr for the electromagnetic testing (*source: https://3.imimg.com/data3/LN/SA/MY-1364469/profometer-rebar-detection-system-500x500.jpg*)

In historic objects of ruins, an electromagnetic device is helpful in searching for fragments of old steel elements, which were often anchored in the wall (e.g., fittings, hinges, handles, fragments of gates and bars, etc.)

Sclerometric examination

The Schmidt hammer test method is a sclerometric method that relies on the relationship between the surface hardness of a material and its compressive strength. In Poland, the test is carried out in accordance with PN-74/B-06262 "The sclerometric method for testing the compressive strength of concrete using the Schmidt type N hammer".

The sclerometer is mainly used in concrete constructions but it is also used in elements made of other materials.

The Schmidt hammer is a device that allows the assessment of the surface hardness of concrete based on the measurement of the jump from the surface, of the stem with the spring system, which is striking with a certain force. The measured value is the so-called number of reflection (L), which is read on the hammer scale.

There are 4 types of the Schmidt's hammers, differing in impact energy: N – medium (normal), L – light, M – heavy (massive), P – swinging.

Research procedure:

- place the hammer perpendicular to the surface to be tested and press slowly.
- pressure causes the shock mass to regress and to pull the shock spring. (Withdrawal of the mass causes an automatic release and the impact on the spindle. After the impact, the mass jumps on a certain length, which is recorded with the help of the indicator).
- reading on the scale – the number of reflections L.
- the rules of measurement are identical for all types of hammers.

Number of test sites:

- perform the test at least in 12 places in one element
- at least 5 readings should be made at the test site.

Places where results can be unreliable:

- at a distance of less than 3-4 cm from the edge of the element,
- a corroded surface,
- elements with low stiffness,
- moistened surfaces (understated readings),

Interpretation of results

Based on the research, the value of the so-called the number of reflection L is obtained, which is read directly from the hammer scale. Then, based on the number of reflection and regression curves determined individually for each material, it is possible to estimate the compressive strength of a given element.

Formula for determination of the compressive strength R:

$$R = aL^2 + bL + c$$

where:

R - compressive strength [MPa],

L - the number of reflections based on the arithmetic mean of 12 test sites,

a, b, c – parameters determined on the basis of a regression curve, developed individually and experimentally for each material

Thanks to the sclerometric tests, the following can be determined:

- ✓ surface hardness of the element tested,
- ✓ compressive and tensile strength based on its relationship with the surface hardness,
- ✓ homogeneity of the elements tested,
- ✓ adhesion of finishing layers (adhesion of plasters to a construction element),
- ✓ occurrence of local defects, discontinuities, or disturbances in the structure of the element.

Thermovision examination

Thermovision is a diagnostic method based on the detection of radiation in the infrared spectrum and the conversion of this radiation into a visible image. Thanks to this, the temperature distribution and their values on the external surface of the object tested can be observed and evaluated. The creation of the image consists in registering by the camera the radiation emitted by the object observed, and then processing it into a coloured temperature map. The resulting map is then interpreted graphically, where each temperature is assigned a different colour or shade of grey, so that the thermal image of the object is seen in the viewfinder or in the computer.

In buildings in ruin, the thermal imaging camera finds its application for recognizing various elements. Due to the phenomenon of thermal accumulation, materials with different densities will obtain different temperatures. There may be a situation, in which the materials have reached a temperature balance with the surrounding and will have the same surface temperature, regardless of their density. Then the test should be extended to the active thermovision. The active thermovision consists in temporarily heating or cooling the examined part of the element. Due to differences in the physical construction of materials, they will heat or cool at different rates. By observing in real time the temperature changes of the fragment examined caused by the external factor of elevated or reduced temperature, it is possible to identify the elements. When performing active thermovision, the influence of the thermal shock on the elements tested should be taken into account. The test temperature should be chosen in such a way as not to damage the object tested.

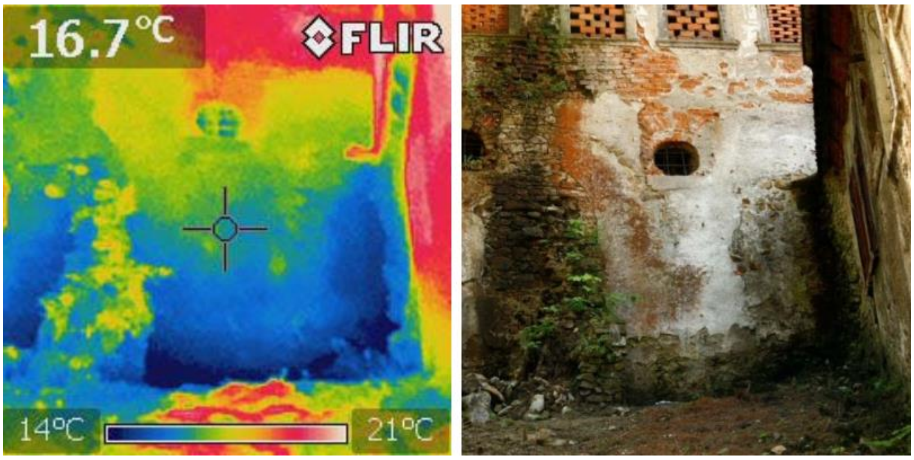


Photo 5 Non-destructive testing methods for building structures as a recovery logistics tool for the renovation of the Palace in Gorzanów 0

Advantages of testing with a thermal imaging camera:

- infrared thermography is a non-destructive and non-contact research method,
- radiation is safe for people and the environment,
- a wide range of applications and a wide range of temperatures measured,
- the measurement is made in real time,
- it enables effective measurement of the temperatures prevailing on the surface of hard-to-reach objects.

Limitations during the test:

- the high cost of the apparatus (in the case of active thermal imaging, the additional cost of the thermal stimulation system),
- between the infrared camera and the test surface there must be no obstacles,
- the phenomenon of convection, radiation, and heat conduction distort the measurement,
- the difficulty of obtaining homogeneous heating of a large surface when using the active infrared thermography,

- using the active thermography, defects can only be detected in the surface layer of the material.

Thanks to thermal imaging, the following can be determined:

- ✓ material differentiation hidden under the face layers,
- ✓ detection of defects, air voids, discontinuities in the material,
- ✓ detection of moisture,

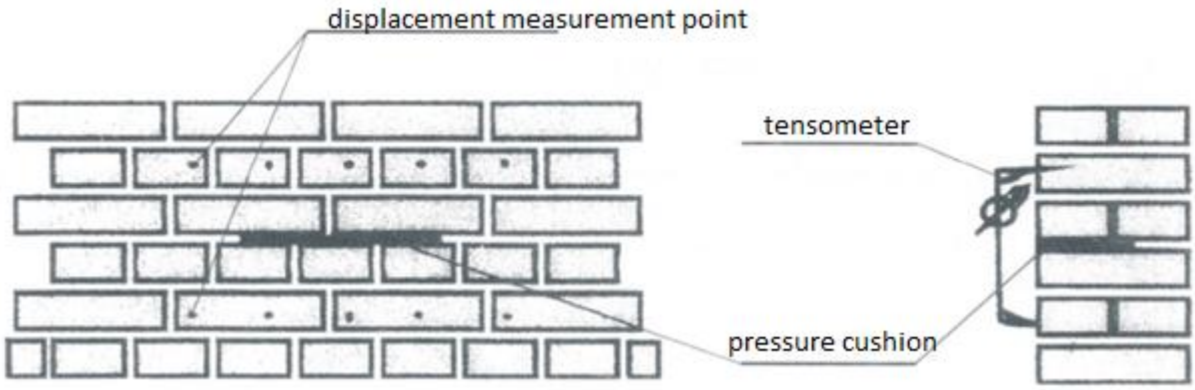
Testing by pressure cushions

The test with the use of the pressure cushions is one of the basic methods of evaluating of existing masonry structures in the countries of the Western, South Europe, and in the United States.

Pressure cushions are used for measurements of two types:

- stress measurement in the masonry with a single pressure cushion,
- measuring the deformability of the wall and possibly its strength by means of two pressure cushions

The method of determining stresses in the masonry by means of pressure cushions is very simple. The first step is to properly arrange the control points and measure the distance between them (with an accuracy of 0.001mm). Next, a furrow (by cutting or notching) in which the pressure cushion is placed, should be made between the measuring points. The pressure cushion is made of a metal sheet and its shape depends on the shape of the furrow made. Next, the cushion is filled by a liquid and the stresses caused by filling the cushion and increasing its volume in the masonry are monitored on a current basis using a manometer. Measurements between control points are performed on a regular basis. The value of the manometer must be read when the values of the distance from before the furrow was made are equalized. After proper reduction of the value depending on the shape of the cushion and the pressure surface of this cushion, the value obtained is the value of stresses in the masonry. Based on the analysis of the technical literature, the measurement error was estimated at no more than 33%.



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On the basis of measurements, the stresses in the wall by means of the formula are determined:

$$f_m = Q\ K_m\ K_a$$

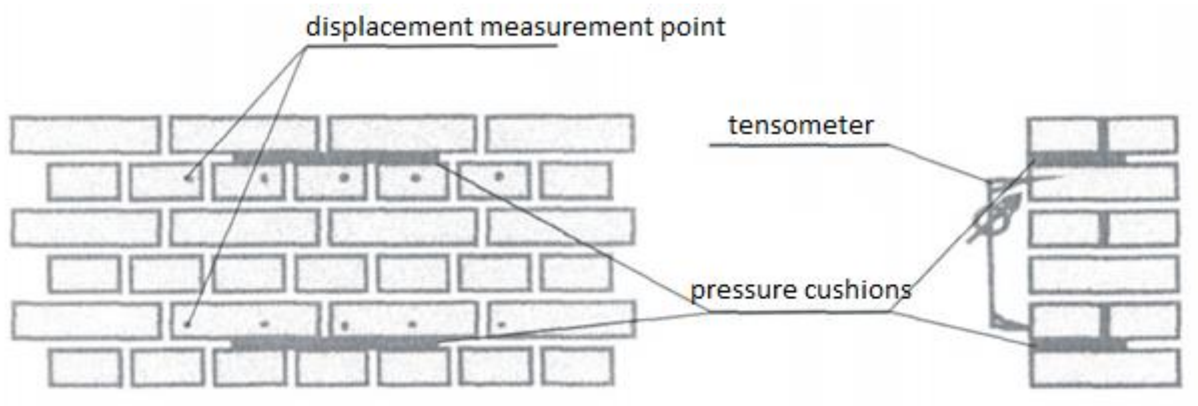
where:

Q – pressure in the pressure cushion,

K_m - calibration constant of the pressure cushions,

K_a - the ratio of the surface of the pressure cushion to the surface of the hole in which it was placed

Measuring the deformability of the wall consists in making two furrows and fixing cushions in them. Between the furrows the control points should be marked and distance measurements on them should be taken. Determination of deformability of the wall consists in describing the relationship of stress increase to strain increase (Young's modulus) in the masonry structure.



In order to obtain the result of the compressive strength of the wall, it is necessary to put pressure in the cushions to cause local destruction of the masonry structure. The destructive pressure will be the limit strength of the masonry structure. Destruction is not reversible, and the test becomes a destructive test.

$$E_t = \frac{\Delta f_m}{\Delta \varepsilon_m}$$

where:

Δf_m - measured stress increase,

$\Delta \varepsilon_m$ - measured strain increase

Thanks to pressure cushions, the following can be determined:

- ✓ stresses in the wall,
- ✓ compressive strength of the wall,,
- ✓ basic wall parameters such as the Young or Poisson modulus.

3.2.2. Biological corrosion tests

The term of biological corrosion, also called the biodeterioration, in construction it is various forms of destruction of building elements caused by the action of living organisms, the so-called biological pests. They are mainly green plants, house fungi, mold fungi, insects, algae, lichens, and bacteria. As in the case of salinity, the prerequisite for most of these organisms is moisture, and its elevated level is responsible for the intensification of corrosion processes.

Another type of classification is the division into processes responsible for the formation of corrosion phenomena of building materials and objects. It can be distinguished the chemical assimilatory and dissimilatory biological corrosion. The first one is the most common form of this process and takes place when the material is degraded because of its nutritional value. The second, the chemical dissimilatory biodeterioration (corrosion) occurs when metabolites of microorganisms damage the material.

In the case of masonry, the chemical assimilatory corrosion is of little importance due to the minimal amounts of nutrients. It is limited only to those walls, in which wooden elements were used in the structure or wood was used as a material for roofing and communication elements, e.g., bridges and viewpoints on the top of the walls. On the other hand, the phenomenon of dissimilatory biological corrosion is of great importance. The fouling of the surface of materials by living organisms known in the literature as the "biofouling" can cause a number of adverse changes inside and on the surface of the walls, causing corrosion, pigmentation or the release of toxic metabolites into the material.

Another classification is the classification of effects that occurs during the corrosion: hygiene-sanitary, technical, and aesthetic. The hygiene and sanitary effects consist in the deterioration of the degree of health of objects for people and animals, in the case of walls in ruin are not significant. Technical effects mainly consist in lowering the strength of elements and structures, which leads to their slow degradation. Paralysis of biological corrosion has also an aesthetic meaning, as it decreases the aesthetic value of elements infected.

Due to the mentioned dominance of the dissimilatory biological corrosion, the presence of insect and house fungi is of minor importance in the case of walls. For this reason, only those organisms that can lead to significant degradation changes are described below.

Algae are a group of organisms separated on the basis of morphological and ecological criteria. This name is traditionally defined as several unrelated evolutionary lines of the thallium organisms. Algae are photosynthesizing plants thanks to the chlorophyll contained in them. Most species live in the aquatic environment, and only a few outside it. These organisms do not have diverse elements: leaves, stems, and roots.

Due to the fact that they need water for development, it is usually possible to meet them in the place of increased humidity. They grow over the ground floor of the building and places where there is increased humidity. Their habitat are mostly natural stones and brick, but they also occur on joints and plasters. Initially, the slow expansion becomes more intense with time. Development usually ceases when the humidity conditions change.

Lichens are a cluster considered by many scientists for fungi. These are the thallus organisms formed by linking the algae cell and the fungal hypha, most often to the ascomycetes or basidiomycetes. Lichens are symbiotic and self-sufficient organisms, thanks to which they can live in places inaccessible to other creatures.

They grow on the rocks, stones, walls, and roofs. They are quite resistant to low and high temperatures, and thanks to the ability to draw moisture from the air, they are independent of the conditions on the ground. Due to the colour of fruiting bodies (black, grey), they are often treated by users as dirt. They do not have a major impact on the degradation of materials but affect the aesthetics of the wall surfaces (Figure 17).

Brophytes is a type belonging to the plant kingdom, including spore plants with regular generational change and the dominant sexual generation, i.e., the gametophyte. From the spore grows a filamentous green creature called tangles, from which gametophytes grow, having a distinct stem and leaves. Brophytes are self-supporting plants.

They develop like algae in places of high humidity. They can grow on both stone substrates and on brick walls. In places where they develop in large quantities they cause moisture retention and growth inside the wall.

Green plants.

The appearance of even the minimum amount of humus in the crevices and on the top of the wall is accompanied by the development of green plants. Initially, the dominant first of all are small plants, one or two years old and grass. Their growth is particularly intensive in places where elevated humidity persists. Decomposition processes cause the appearance of humic acids in the masonry and an increase in the amount of nitrates. Over time, perennial plants, shrubs, and trees appear along with the growth of the humus layer (plant decomposition, blowing the soil). The effects of the development of higher vegetation are similar to those in the case of low vegetation, additionally there is a danger of the walls getting overgrowth by roots. The growing root system (most often by the network of joints) causes delamination of the wall leading to the formation of quite serious damage.

Organisms that cause degradation of building materials to their life processes need food. In most cases it is cellulose which is one of the components of wood. Therefore, the greatest damage can be expected in places where wood and wood-based materials are built. On the other hand, some organisms may function without access to wooden materials, therefore the assessment of the object in terms of existing concentrations of biological corrosion must be comprehensive. A significant part of the research is of macroscopic nature and can be carried out during visual inspection.

During the visual inspection the presence of the following organisms is checked: insects, house fungi, fungi-molds, bryophytes, algae, lichens.

Insects

The extent of the problem does not allow for the introduction of all divisions and classifications that characterize insects as technical wood pests. For this reason, only the division into groups related to their harmfulness is given:

- The most harmful, occurring en masse, causing the greatest losses: hylotrupes, common furniture beetle, hadrobregmus pertinax, european lyctus beetle.
- Less harmful, causing large losses, but rare: ernobius mollis, fan-bearing wood-borer, deathwatch beetle, red-brown longhorn beetle,
- Not-destructive to wooden elements (insects living in the facility)

Groups of damage to wooden elements caused by the operation of technical insects of wood pests depending on the depth of damage can be divided into three groups:

- Surface walkways with a depth of up to 2mm – usually caused by larvae of tree pests as they grow or shortly after being cut. The group of this type of pests includes, e.g., woodworms.
- Walkways with a depth of up to 5 mm – they are usually are formed after cutting the tree, sometimes also after its treatment, when the bark is left on it.
- Walkways with a depth of more than 5 mm – damage of such a depth is the result of insect feeding mainly, the so-called technical wood pests. In this case, the damage can be so serious that it sometimes destroys the element completely.

During the visual inspection, after finding the presence of places affected by biological corrosion, it is necessary to assess its activity. This mainly applies to places affected by insects. Quite often, the feeding places observed during the inspection are classified as active only on the basis of the presence of outlet holes. During earlier impregnation works, holes are usually not closed. The easiest way to determine the feeding activity is to direct the stream of light along the element being assessed and observe whether wood dust is spilled from the element. The activity of insects is also indicated by fresh sawdust mounds on the attic floor. In the case of active habitats, the sound of accompanying feeding of larvae is clearly audible. The full credibility of the assessment can only be obtained through destructive testing. In the places of fresh holes or falling of wood flour, with the use of a sharp tool a layer of wood is revealed in order to search of insect larvae.

House fungi

Elements distinguishing house fungi:

- Mycelium – abundant and fluffy, most often develops on the surface, but can also penetrate deeper, sometimes overgrowing the whole element. The mycelium is in the form of thin threads, the hyphae of the mycelium produce pieces – clasps and medallions – features defining this class.
- Cords – consist of several layers of hypha, formed by changing conditions, length over 10 m and a thickness of 2 - 8 mm, they are used to transport nutrients and water in the direction in which the fungus develops.
- Fruiting bodies – in conditions favorable to development, mycelium produces fruiting bodies, spores grow on the hymenophore of sporocarps. The fruits of the house fungi are very large and can be up to several dozen centimeters.
- Spores – microscopic in size, sown from the fruiting body allow further expansion.

Classification of fungi due to their harmfulness:

- A – fungi causing a strong and quick decay: serpula lacrymans, coniophora puteana, fibroporia vaillantii, tapinella panuoides.
- B – fungi, which are harmful in open areas (warehouses, bridges, pillars) and with small significance in buildings: gloeophyllum sepiarium, neolentinus lepideus, antrodia serialis, daedalea quercina.
- C – fungi attacking wood surface: claeve, phlebiopsis gigantea.

Fungi-molds

The identification of fungi-molds is a rather troublesome matter. On the one hand, the designation of the species seems to be the most intentional (identifying the threat), on the other hand it involves quite big difficulties. The first problem is the size, the fungi-molds are visible only with an armed eye (preferably in a microscope), and so recognizing them is troublesome. Another is the fact that on a small area there can be several different species, in different development phases.

Research on the site is limited to:

- Determination of places of occurrence
- Provide the range of impact

- Determining the intensity of the phenomenon
- Performing photographic and graphic documentation

WARNING

Research to determine the presence of molds should be outsourced to specialized laboratory units. The mycelium fragments or spores obtained in a proper way are grown on special media under laboratory conditions. Only then, on the basis of morphological studies, a specialist mycologist or microbiologist can identify species that occur or dominate, and then it is possible to determine their harmfulness.

3.2.3. Macroscopic research - outcrops

Outcrops are non-destructive. Thanks to the outcrops, it is possible to identify materials and determine their technical condition. In order to make outcrops, the materials covering the element tested should be removed. The top layers (plaster) are usually removed, or deep layers (wells), but then the damages have a minimized surface. Always before removing the top layers in order to reveal the structure, make sure that these layers are not subjected to the conservation protection.

Outcrops should be documented by drawing and photography.

The following types of outcrops are distinguished:

- point (holes)
- linear (forge, furrows, linear edging)
- surface (forge, exposures, excavations)

Point outcrops

Point outcrops are made in the form of boreholes. The boreholes are intended to obtain information about: material homogeneity (full depth or not full depth), material type (incomplete depth), continuity of the partition (full depth), and thickness of the partition (full depth).

Performing the test:

- the test is performed using a driller with the right type of a drill (for concrete, brick, wood, steel) and of appropriate length,
- the cuttings are observed (color, type, humidity) during drilling. This will allow to specify the material of the element that is examined,

- the drilling is performed with constant force, analyzing the size of it, which is necessary to drill through individual parts of material (this will allow to roughly evaluate the quality of the material),
- the abrupt nature of the drill's work (in case of occurrence) should be noted, including the actual depth of the borehole (this will allow to determine approximately homogeneity of the material, detect voids or change of a material)

Linear outcrops

Linear outcrops are designed to examine repeating elements (e.g., brick dimensions under the plaster) or they are of a pilot nature before making surface or other outcrops (e.g., forging a furrow until it encounters a supporting beam).

Performing the test

The test is performed using a hammer driller with the appropriate tip (chisel) or by hand. It should be preceded by manual overcutting of the material tested in order to limit the damage zone.

Surface outcrops

Surface outcrops are aimed at obtaining information about repeating elements, or the relationship between a greater number of construction elements. As an example, an examination of the method of wall binding and the arrangement of bricks in them can be given.

This type of outcrops is particularly valuable, the amount of information possible to obtain is very extensive. Such outcrops allow to assess: technical condition of the structure (behavior), type of material, manufacturing technology, originality or secondaryity of the solution, age, and order of formation.

In historic buildings, the most frequently the surface outcrops made for walls and ceilings are found.

During the construction of the outcrops of ceilings, attention should be paid not only to construction materials, the method of support on walls or other structural elements, but also to non-structural materials (e.g., pugging), which may also indicate the originality and age of the structure.

In the case of walls the surface outcrops most often (this is the most reasonable) should be made in the corners of the walls and above the openings. The outcrop over the hole will allow to determine the material, technology, and type of lintels and the way the ceilings are supported. The outcrop in the corner will allow two walls to be tested simultaneously with a slightly larger test area, and will also allow an analysis of how these walls are connected.

Performing the test:

- marking the place of examination
- cutting the outline of the planned range of the outcrop
- removing the plaster layers
- clearing out of the outcrop (making the bond visible)
- additional forge at the interface of walls (penetration)

3.2.4. Literature of the chapter

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3.3. Laboratory tests of materials and structural elements

3.3.1. Compressive strength test

During the analysis of the structure, the most important parameter is the compressive strength of its components and its very own. The necessity to carry out strength calculations may be caused, among others, by the need to load the structure, change the static scheme, adaptation, superstructure, expansion, reconstruction, etc. Currently, several non-destructive or medium destructive methods (described in the first part) are used to determine this parameter. On the basis of numerous studies, an error of the strength estimation by means of indirect methods at the level of 20% was found. In order to obtain a very accurate result, the destructive laboratory test should be performed.

The purpose of the test

The purpose of the test is to determine the compressive strength of the masonry. In addition, it is also possible to determine the splitting tensile strength, Young's modulus, and Poisson's modulus on samples taken. The result of the test is the actual strength of the wall fragment, which is expressed in pressure units.

Research methodology

At present, there are no standards that explicitly regulate the conduct of research for the historic ruin objects. Records regarding similar research on contemporary objects can be found in national standards and instructions issued by research institutes [sources].

In order to determine the strength parameters using the laboratory method, a sample of the construction element tested should be taken, then it should be properly prepared and compressed to be destroyed in a hydraulic press.

<u>Conducting the study</u>

Before proceeding with the test, samples should be taken from the element. The method of taking samples and their preparation is important for the final result of the test, therefore in the case of comparative testing, identical methods are recommended.

According to sets of standards and regulations, a minimum of 3 samples should be taken. However, due to the large diversity and difficulties associated with taking samples in historic buildings, it is recommended to take a minimum of 6 samples.

Sampling from the wall is carried out using a driller with a lace drill. The lace may be liquid-cooled during sampling and the moisture of the material will affect the strength result. It is recommended to perform tests after the wall is completely dry.

The diameter of the sample will depend on the structure of the element and the assumed precision of the test (best results are obtained for 150 mm cores). The diameter should be chosen so as to render a representative part of the wall and cause the smallest damage to the structure of the element tested.

The depth of the borehole will depend on the thickness of the wall and the lace. If the walls are not too thick, it is recommended taking samples from the entire thickness of the masonry and testing the central part. In the case of walls of considerable thickness, it is recommended to take samples 5 cm larger than the inner diameter of the lace (e.g., for the Ø150 mm lace, sample length should be 200 mm). A few reserve centimeters of sample height is important due to frequent surface damage to the face layer and uneven fracture during its collection. The lateral surfaces of the sample should then be ground so that they are perpendicular to the cylindrical surfaces and parallel to each other.

Samples prepared for testing should be in the 1:1 proportion (diameter:height). In the case of testing the strength of the wall and not its elements, the sample should be collected in such a way as to render the composite as accurately as possible (it should contain a mortar and masonry material). The more symmetrical the side surface view is, the more reliable test results will be. Depending on the size of the wall elements, the joint should be as close as possible to the center and the central axes should form the symmetry axes of the sample.

Properly prepared samples can be pressed parallel or perpendicular to the load direction in the wall. The composite is anisotropic and will exhibit different material parameters depending on the direction of the test. It is recommended to compress the element in the direction in which the element is compressed in the wall. The sample scheme together with the test diagram is shown below.

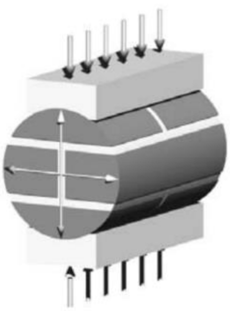

Fig. 1 Diagram of the test of the wall core 0

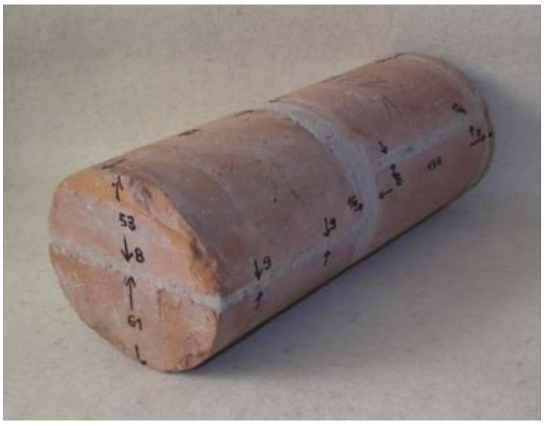

Photo 6 Core through the thickness of the wall. 0

Photo 7 Samples prepared for testing. 0

Properly prepared samples are placed in a hydraulic press and then they are subjected to compression with a corresponding increase in force (N/s). The force increase should be set individually in each test depending on the structure of the element being tested. The graphic below presents a diagram of the compressive strength test of the masonry and the samples prepared for testing.

Photo 8 Test stands – the Controls Advantest 9 hydraulic press

Interpretation and presentation of results

The compressive strength f, which is expressed in MPa is calculated using the formula:

$$f = n \times \frac{F}{\varphi \times l}$$

where:

$f - destructive\ force$

φ – *diameter of the sample*

l – *length of the sample*

n – *correlation coefficient*

Accuracy of calculation up to 0.1 MPa.

The correlation coefficient based on the tests [Brencich A., Sterpi E., Compressive strength of solid clay brick masonry: calibration of experimental tests and theoretical issues, Structural Analysis of Historical Constructions, New Delhi 2006] is recommended to be between 1.8 and 2.2. It depends on: the proportion of the sample, its diameter, and the slenderness of the element tested. It should be adopted individually based on the experience of a laboratory technician or expert.

When analyzing the results, it is also important to determine their standard deviation. It will testify to the homogeneity of the element tested or the accuracy of the research conducted.

<u>Test report</u>

The test report should contain the following information:

- date and place of sampling,
- type, origin of the element,
- number of samples taken,
- date of receipt of samples by the research laboratory,
- sketch of the sample, if necessary, showing the area of the surface to be loaded, the size and direction of the load,
- the method used to prepare the surface,
- humidity during the test (measured by gravimetric method on samples after destruction),
- destructive load in N and dimensions of each sample in mm,
- strength of samples in MPa with an accuracy of 0.1 MPa,
- description of the type of destruction for each sample,
- photographic documentation from the study,
- insights if they are.

3.3.2. Humidity testing by the gravimetric method

The basic sources of moisture supplying the walls are: water in the ground pulled up capillary, water coming from atmospheric precipitation, water hygroscopically absorbed, and condensing inside the materials and on their surface. Other sources of moisture occurring in construction industry that is, water technologically introduced into the facility, originating from installation failures, and generated by man are of little importance in the case of walls of objects in ruin.

In the case of walls of buildings in the form of permanent ruin, ground water and rain water have the greatest impact on degradation processes.

Ground water. Water from the ground threatens not only the underground parts of the facility. It can be transferred to higher, above-ground parts of the wall due to the phenomenon of capillary rising. The capillary rising involves transporting water and slowly soaking areas of material that do not come in direct contact with the source of moisture. The capillary rising from the foundations may be the reason for the walls getting moist up to a few meters high. The height of the capillary rise depends on the structure of the material, primarily from its porosity and the structure of pores and capillaries. The height mentioned is inversely proportional to the diameter of the capillaries. This means that in fine-porous materials with a small pore and capillaries diameter, the capillary rise is the highest. For thick walls erected from ceramic bricks, it can reach even several meters above the level of the water. In stone walls, the height of the capillary rise depends mainly on the type of rock. In the case of sedimentary rocks (limestones, sandstones) it is definitely the highest. In the case of igneous rocks, the capillary rise is minimal or does not even occur. This does not mean that in walls made of igneous rocks, or metamorphic rocks of an igneous origin, there is no phenomenon of the capillary rising. Due to the fact that a wall also consists of mortar, the water is pulled up to the higher parts of the wall by a network of joints.

Rain water. Rain water is the largest quantity in the total water balance in the immediate vicinity of the facility. It can cause the wall to get damp in a direct and indirect way. With the direct moisture we have to do when the rain water hits the exposed elements (e.g., wall top, side surfaces). Into dampness in an indirect way comes when the rain water falls over the walls in the ground floor or the so-called splash water occurs.

The greatest damage is observed in the ground floor (no insulation) and on the top of the walls (in the absence of shielding elements). The flowing water also leads to damage to the face of the walls, this effect is particularly visible in walls of variable thickness. Movement of moisture in a wall in the first stage results in the dissolution of mortar binding substances and damage to the joints or their complete elimination. This process is mainly caused by rain water flowing down towards the ground. As a consequence, there is a reduction in the load-bearing capacity of the wall parts which are missing from the joints. The next step is the systematic separation of the masonry material (brick, stone) from the wall.

Humid materials are subjected to accelerated destruction also due to the cyclical freezing and thawing of water contained in pores and capillaries. Water in the pores of materials and in cavities of the wall freezes and increasing its volume, which destroys the material. Degradation as a result of the so-called frost damage is particularly visible on the facades of southern facilities due to the repeated action of freezing and thawing during one season. Moistening of materials also accelerates the chemical corrosion of metal elements that may be in the walls.

The purpose of the study

The purpose of the test is to determine the moisture status of partitions in the facility. The markings allow to obtain information on the scale and range of moisture and they allow to determine the source of moisture. Markings conducted at various depths and heights provide information on the moisture distribution in the masonry structure.

Depending on the needs, the tests may: have cognitive character (scientific research), decide on the scope of repair work (pre-design phase of renovation), inform about the possibility of embedding further materials (finishing works), or provide evidence (claim and court cases).

Research methodology

In Poland, the direct measurement (gravimetric, laboratory) is considered as the only reliable way to measure moisture content. Despite the simplicity of the weight moisture content determination and the availability of research methods, a whole range of activities related to obtaining reliable results remain a problem. Their credibility is influenced by the method of material sampling, depth and sampling height, the number of measuring points, and the interpretation of the results obtained.

Sampling technique

The first problem is the method of obtaining material for testing. Sampling with boring devices is not recommended because of the drying of the material for testing. Based on the literature it is recommended to forge or use pipe punches. In many objects, both methods are difficult or impossible to apply. When sampling at larger wall depths, a large wall fragment would be damaged during the removal of the material. The use of pipe punches is limited only to the collection of samples at a shallow depth and applies to materials of low strength. When removing from a deep depth, the problem is to remove the pipe punch with the material from the partition. A great simplification is the pre-drilling of the hole and driving a pipe of larger diameter at the location of the hole made. In this case, the sample should be taken after several hours from drilling. This time is necessary to equalize the humidity in the place of sampling.

The simplest way and probably the most commonly used (not recommended) is drilling and removal of drill cuttings for testing. This method entails an error related to the decrease in the value of the results obtained. During drilling, the drill warms up and the water evaporates. Depending on the drilling speed, the drill used (diameter and condition of the blade), and the material, the temperature in the hole can be up to tens of degrees (according to the authors' research). Significantly smaller errors occur when using low-speed drilling or drilling rigs with crowns not cooled by water. For low-speed drilling, the amount of heat caused by friction is much lower than for high-speed drilling. The use of devices with simultaneous water cooling is excluded by the nature of the research, while non-cooled crowns are subjected to a rapid wear and their use is limited to low-strength materials.

Therefore, regardless of the drilling technique, when the material is collected for the moisture tests, drill cuttings are dried. The weight loss of a moist sample should be taken into account in the calculation of a moisture content.

Depth and height of sampling

Another important problem is the depth and height from which samples should be taken. Due to the fact that the distribution of humidity in a wall is not linear, differences in results should be expected at different depths. The question remains whether, due to the heterogeneity of the distribution, several samples should be taken from various depths, or one representative for the entire partition. Polish-language sources provide information about one sampling at different depths and a height of 0.5m above the floor level. In the case of foreign recommendations, there are three taken from various depths (three depth profiles) and three height points on one axis. Depending on the approach, one or 9 samples can be taken within a small area of the partition.

Trying to limit the large number of samples taken and at the same time obtain the necessary information, the authors in their research take a minimum of two points on the axis, and the number of depth profiles depends on the type of the partition tested. Taking a minimum of two points at different heights allows to determine the amount of water rise in the walls above the ground level. In the case of cellar walls, it makes it easier to identify the source of water causing moisture. As a rule, samples are taken from the wall just above the level of the floor (inside the building) or terrain (outside), and at least one above the first (e.g., at a height of 1 m).

Another problem during the research is the adoption of a reliable number of samples from the object. This number depends on many factors, and the most important ones include: the dimensions of the object tested, the method of its foundation, the basement surface, material and constructional homogeneity of walls, the condition of partitions, and the purpose of the tests.

Based on the experience of the object moisture content tests, the basic principles of material sampling were determined.

- Samples should be taken from the depth of 1/3 - 1/4 of the thickness of the wall. The test material must come from the entire length of the hole.
- During sampling the material cannot be overheated.
- In order to determine the moisture distribution depending on the height of the wall, the test should be carried out in the floor level (inside the building) or terrain (outside), and at least one above the first (e.g., 1m high). In places where the height has been changed, it should be measured in each case.
- Cuttings should be sealed in a container and if it is necessary to transport it, store it in a refrigerator (if the moisture determination is carried out over a longer period from the moment of sampling). In the case of several days of research on the object, the samples can be frozen and transported to the laboratory in such a state.
- The openings from which the material for testing was taken, should be supplemented with a material compliant with the one taken from the wall.
- An additional photographic documentation of the places of sampling should be performed. This will allow to apply the test points to the drawing documentation.

Laboratory tests

The method of making the moisture content determination is specified in the PN-EN ISO 12570 standard „Hygrothermal performance of building material and products – Determination of moisture content by drying at elevated temperature".

Before the drying process, the test specimens should be weighted to the nearest 0.1% of their mass. Then, the samples should be dried to a constant mass at the temperature specified in the relevant product standard. A constant mass is achieved when the change between three consecutive weighings performed within 24 hours is less than 0.1% of the total mass. The samples should be cooled in a desiccator and weighed after reaching a temperature of 30°C to 40 °C with the same accuracy as described above. Samples are weighed before they are completely cooled down to minimize the re-absorption of moisture.

The weight moisture content is determined according to the formula:

$$w_m = \frac{m_w - m_s}{m_s} \times 100\% = \frac{m_{water}}{m_s} \times 100\%$$

where:

w_m - weight moisture content [%]

m_w - mass of the moistened sample [kg, g]

m_s - mass of the sample to be dried to a solid mass [kg, g]

m_{water}- mass of water in the sample [kg, g]

Interpretation and presentation of results

In most studies dealing with the problem of humidity research, there is (rightly) information about the lack of standards specifying the acceptable moisture content of building materials. At the moment, the information supporting the interpretation of the results obtained comes from several different sources. The situation looks the best when it comes to requirements for the substrates on which specific construction works are to be carried out. Information on these requirements can be found in the "technical conditions of execution and acceptance of construction works" or in safety data sheets, approvals, and certificates of embedded products.

When interpreting the results of weight moisture content tests of building partitions, two tables below are helpful. The first of them comes from the expired standard PN-82/B-02020 "Thermal protection of buildings" and gives permissible values for the weight moisture content of masonry materials. The data provided indicate the humidity value in the so-called dry state and its maximum increase. In total, the value obtained only informs about the value at which the wall ceases to be "dry".

Tab. 1. Permissible weight moisture content of materials in external building partitions (part of the PN-82/B-02020 standard "Thermal protection of buildings").

No.	The type of material or partition	Humidity before the period of moistness [%]	Permissible humidity increase [%]
1.	Wall made of ceramic bricks	1.5	1.5
2.	Wall made of ceramic hollow bricks	1	2
3.	Wall made of silicate brick	3	2
4.	Aerated concrete	3	4

More detailed information is provided in the second table. The humidity ranges and the description of the wall were assigned to the next humidity levels. The table was developed only for ceramic brick walls and for obvious reasons its automatic use for walls made of other materials is impossible.

Tab. 2. Humidity levels of walls.

Level	Weight moisture content [%]		Description
	Ceramic brick	Limestone with a porous structure	
I	0 - 3	0 - 4	Walls with acceptable humidity
II	3 - 5	4 - 6.5	Walls with increased humidity
III	5 - 8	6.5 -10	Moderately moist walls
IV	8 - 12	10 - 15	Very moist walls
V	> 12	> 15	Wet walls

The simplest solution is, of course, the conversion of ranges taking into account the density of subsequent materials (the author included such a proposition for three other materials). The given ranges result only from simple mathematical calculations and therefore should only be treated as a proposal that facilitates the interpretation of the results obtained.

Report on humidity tests

The report from the tests should include: sampling method, equipment used for collection, description of the sample taken (type of material), number of samples for individual storeys, heights on which the material was collected, date of collection, place of examination, date of testing, apparatus and equipment used in the laboratory.

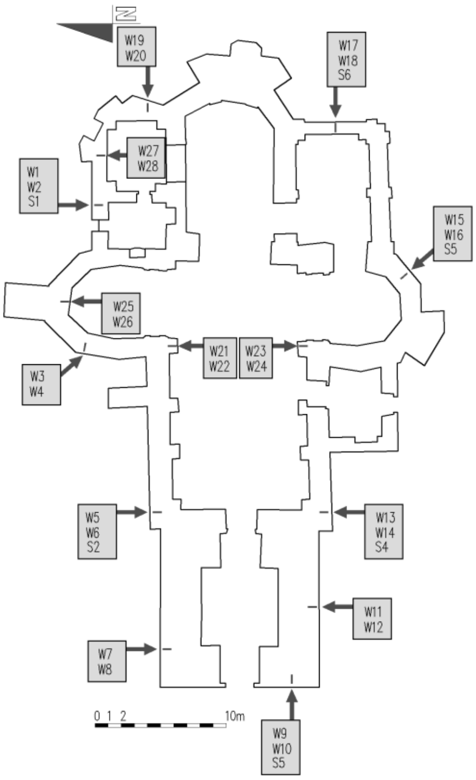

Fig. 1. Ground floor. Place of sampling for testing.

Tab. 3. An example table of moisture test results

Test point	Place of collection	Height [m]	Moisture content [%]
W1	north wall	0.1	6.9
W2	north wall	1.0	1.8
W3	north wall	0.1	6.1
W4	north wall	1.0	4.1
W5	north wall	0.1	10.0
W6	north wall	1.0	2.7
W7	north wall	0.1	8.5
W8	north wall	1.0	3.5
W9	western wall	0.1	4.0
W10	western wall	1.0	3.2
W11	south wall	0.1	6.2
W12	south wall	1.0	5.5

3.3.3. Salinity tests

Water-soluble salts are among the most dangerous factors damaging building structures. It is quite common to find out that they are the cause of the greatest damage in the basement of a building. Their high concentrations can sometimes lead to complete destruction of building parts, which are salted. The carrier of salt in building materials is water, and damages arise as a result of the salt crystallization processes during its evaporation. Therefore, salinity largely correspond to places with high humidity. The most common salts occurring in buildings are: sulphates, chlorides, nitrates, and carbonates of sodium, potassium, calcium, ammonium, and iron. In terms of mineralogy, the most common salts are: halite, sylvite, bishofite (chlorides); nitronatrite, nitrocalcite, niter, nitromagnesite (nitrates); mirabilite, arkanite, epsomite, kiserite, thenardite, gypsum (sulphates); termonatrite, natron (Carbonates). In the object, only one type of salt is extremely rarely. In reality, we usually deal with structures with mixed composition.

Salt formation process

From a chemical point of view, salts are substances formed as a result of an acid neutralization reaction with an alkali. The reaction of the salt depends on which substances were involved in the process of its formation. In the case of strong acid and base as well as a weak acid and base, it will be close to neutral. Salts may also have acid reactions with strong acid and a weak base and alkaline in the reverse system. It should be remembered that these compounds can then react with building materials such as the corresponding acids and bases. From the construction point of view, the most important are salts that are readily soluble in water, so those in which it easily breaks down into ions. The chemical composition of salt is the factor responsible for the level of danger. It has a direct influence on the scope and intensity of destructive processes related to the presence of these compounds in the material.

Sources of salinity

Excessive salinity is a problem primarily of old objects that do not have insulation, and thus they are exposed to constant contact with moisture. However, this problem may also apply to protected objects, in which the moisture protection was insufficient or the material used had high primary salinity. It should be remembered that water penetrating and then moving in the materials is full of impurities. Such contaminants are also salts dissolved in it. The most important sources include salts:

- included in building materials,
- pulled up in a dissolved state from the ground,
- getting along with atmospheric precipitation,
- introduced during maintenance and impregnation treatments.

The raw materials from which building materials are produced contain specific amounts of soluble salts. In addition, further compounds may be formed in the process of making materials and their incorporation. Quite large concentrations of building salts are found in cement, gypsum, and calcium binders, but also in masonry materials. In the case of monumental buildings, large amounts of salt go to the walls together with moisture pulled from the ground. This mainly applies to nitrates and chlorides. In connection with the above, that within the old walls there were often ditches with impurities and buildings with inventory, in the ground there are large amounts of nitrates and nitrites. Decomposition of dead vegetation further increases of these compounds within the objects surroundings. The presence of chlorides may also be caused by the use of salt in the winter. The salt goes then with the water to the ground, or in the form of a "slush" directly to the basement walls. The main source of sulphate salts is the reaction of materials with contaminated air, and the effect of the so-called acid rain. Rainwater along with dissolved acid oxides present in the polluted atmosphere penetrates deep into bricks, stones, and mortars, enabling chemical transformations leading to degradation of the walls.

Also poorly selected methods and measures used in conservation works can be the cause of the secondary salinity of objects. An example of such works is the cleaning of the facade with agents containing acids or bases.

Destructive salt effects and their distribution

The mechanism of corrosive salt action is based on chemical and physical processes, and the substance that determines the destruction processes is water. Salts as solid substances do not move automatically in the materials. Therefore, in the corrosive processes, those that dissolve very well and well in water take part. In the form of a solution they reach everywhere where water is transported. Their accumulation takes place in a place where water evaporates. The phenomenon of salt movement is called the migration to the surface. The most dangerous processes associated with salts include: crystallization, hygroscopicity, hydration, increase in concentration, and change in the pH of the solution.

The destructive effect of salt is based primarily on the phenomenon associated with the crystallization and expansion of their volume. The resulting pressure is large and sufficient to cause cracking of the pore walls in the material, loosening of the surface layers and, as a consequence, causing its decomposition, scaling, cracking, and disintegration. For a large group of salts, the pressure is from a few hundred to well above 1000 atm. The forces accompanying the crystallization process are so high that after a few cycles even the most durable bricks, stones, and mortars are destroyed. Their value is greater than that created by freezing water.

Destructive salt action can have multiple effects. With continuous transport of the salt solution, its crystallization takes place on the surface of the element. Then it can be speak of a smaller immediate threat of destruction, but a significant deterioration of the surface aesthetics of the material. The salts on the surface of the material can crystallize in the form of stains, efflorescence, fluffy blooms, and glassy coatings. This form depends on the type and amount of salt, as well as on the conditions under which the crystallization takes place.

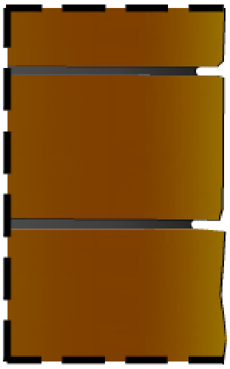

Fig. 9 Salt corrosion of the wall surface with mortar weaker than the masonry material.

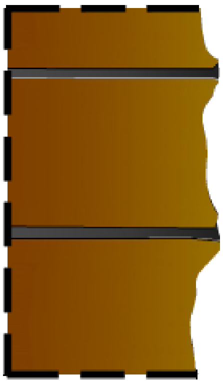

Fig. 10 Salt corrosion of the wall surface with mortar stronger than the masonry material.

In a situation where the speed of solution delivery is lower, moisture evaporates in the depths of the wall and crystallization occurs inside its surface layers. This course of the phenomenon causes much more severe corrosion of the walls. For some time, there are no visible effects of degradation, then there are more serious damage than in the first case. In this way, whole fragments of plasters or external surfaces of walls are damaged.

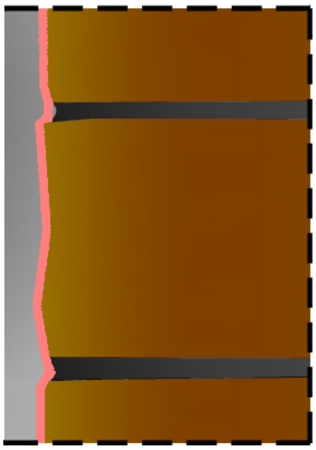

Fig. 11 Salt corrosion at the interface between plaster and masonry

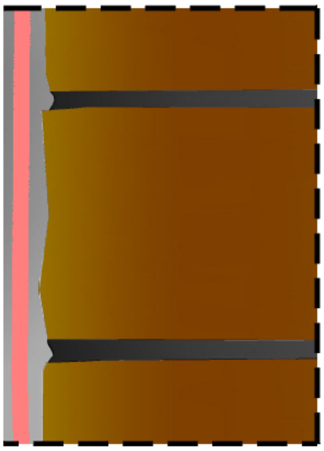

Fig. 12 Salt corrosion inside the plaster layer

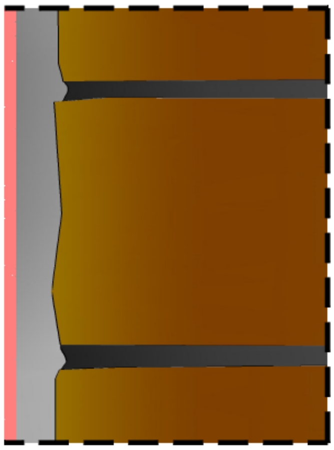

Fig. 13 Salt corrosion on the surface of the plaster

The purpose of the study

The aim of the study is to determine the percentage content of main building salts (chlorides, sulphates, nitrates, and carbonates) in masonry materials, joints, and plasters of objects remaining in the form of permanent ruin. The knowledge obtained on the basis of the results allows for: assessment of the walls condition, forecasting further adverse changes, and conscious adoption of solutions aimed at counteracting destructive phenomena.

Test methods

The most commonly used methods of analysis of the wall's salinity include the liquid chromatography, laboratory analyzes, and ready-made chemical tests. The main advantages of the first one are: the possibility of simultaneous determination up to a dozen or so ions in the sample, short analysis time, detection of very low concentrations, a small amount of sample for analysis and a simple method of its preparation. A drawback, however, is the fairly high cost of the designation. In most cases, ready-made chemical tests are used in the study of salinity. The determinations are performed by titration or colorimetric methods using discs or color scales. During the tests, the load on the walls was determined by: sulphates, chlorides, nitrates, carbonates less frequently. In addition, during the tests, the pH of the material being tested is determined.

Sampling

The sampling technique depends to a large extent on the information to be obtained from the test results. Determination may be the salinity of the wall itself or the wall and plaster. When testing the salinity load of a masonry wall with a secondary plaster, which during the renovation will be forged, only the masonry material should be sampled. If the historical plaster is to remain, both layers should be sampled.

It is important that sampling does not have a surface character, because the salt content in the accumulation areas is often inflated. It is quite difficult to determine the optimal depth and height of sampling and the number of samples. Due to the uneven load of the wall with salts and the variety of bricks used, often the sampling space shifting by several centimeters gives different results.

The material for testing can be taken by bending or by drilling. Drill diameters and drilling speed as opposed to moisture tests do not matter, the material before testing is dried to a constant mass. It is important that the cuttings collected come from the entire depth on which the salinity determination was assumed.

Interpretation and presentation of results

There is no clear indication in the national literature how to interpret the results obtained during the tests. The problem of choosing corrective actions depending on the salinity examined is also not resolved. Only the PN-EN 206 standard contains provisions regarding the maximum concentration of building salts (chlorides and sulphates). However, they refer to concrete and reinforced concrete structures, so they do not apply in the case of the walls of historic buildings. In scientific papers and expert studies, the authors refer to foreign guidelines, primarily German and Austrian. In these studies, various levels or grades of salinity are given, often differing in terms of percentage salinity values within the theoretically the same grade, or the number of levels introduced. Unfortunately, also in these studies, there are no unambiguous indications as to which corrective actions should be implemented. Below in the tables [Tab.1], [Tab.2], [Tab.3] three proposals of results interpretations obtained during the test are presented.

By far the most popular in Poland is the table developed by the WTA, (German Scientific and Technical Working Group for the Protection of Monuments and Renovation of Old Construction, which deals with the protection and care of monuments and historical buildings), which classifies salinity in the form of grades. It distinguishes three load levels of building salts (low, medium, and high) for the three main salt groups.

Tab. 4. Salt load rates according to the current WTA 2-9-04/D instruction "Renovation plaster systems"

Salts	Content in % (mass)		
Level of load	low	medium	high
Chlorides	< 0.2	0.2- 0.5	> 0.5
Nitrates	< 0.1	0.1- 0.3	> 0.3
Suplhates	< 0.5	0.5- 1.5	> 1.5

According to the Austrian Ö-Norm B 3355, there are also three salinity groups. In addition, depending on the grade, the document indicates the absence or necessity of taking corrective actions. For the Group I, no preventive or remedial measures are needed. With the second level of salinity, corrective actions should only be taken in some cases. However, when the salinity in the facility evaluated is at third level, corrective measures should urgently be applied.

Tab. 5. Classification of the salt load on the basis of Austrian Ö-Norm B 3355 standard "Walls drying"

Anions	Salinity in percent by mass		
	I	II	III
Chloride	< 0.03	< 0.03	> 0.5
Nitrate	< 0.05	< 0.05	> 0.3
Suplhate	< 0.10	< 0.10	> 1.5

Another proposal to assess the salinity of materials is provided by the author of the publication entitled "Drying walls and basement renovation" – Frank Frössel. The author introduces five levels of salinity expressed in the mmol of salt/kg with an additional description of each level. In the table, the salinity grades determine the collective values for all salts, which is not entirely appropriate due to the large differences in the harmfulness of individual groups.

Tab. 6. Levels of the salt load based on "Drying walls and basement renovation" by Frank Frössel

Level I	0 to 2.5 mmol of salt/kg	The wall construction shows traces of salt.
Level II	2.5 to 8 mmol of salt/kg	There is a slight load on the construction with salts.
Level III	8 to 25 mmol of salt/kg	There is a medium load on the wall construction with salts.
Level IV	25 to 80 mmol of salt/kg	There is a high degree of the salt load.
Level V	more than 80 mmol of salt/kg	This is an extreme salt load.

Summing up, irrespective of the chosen way of interpreting the results after the tests, it can be only specified the percentage or mmol of salt/kg values of the material salt load value. However, there is a lack of unambiguous answers to the question of how to counteract this phenomenon with a given salinity.

Report on salinity tests

The report from the tests should include: sampling method, equipment used for collection, description of the sample taken (type of material), height and depth at which the material was collected, date of collection, place of examination, date of examination, apparatus and equipment used in the laboratory.

Tab. 7. Sample results of research on the walls of the Janowiec castle.

No.	Height [m]	Depth [m]	Sulphates [%]	Nitrates [%]	Chlorides [%]	pH	Place of sample collection
1	0.5	0.05	0.52	0.12	0.07	6	Tower (ground floor)
2	0.8	0.05	0.69	0.12	0.1	6	Tower (external
3	0.8	0.05	0.96	0.24	0.35	6	Gate
4	0.8	0.1	0.25	0.25	0.15	6	Goldsmiths' Kitchen
5	0.5	0.1	0.24	0.72	0.83	6	North House
6	0.5	0.1	0.12	0.12	0.08	7	Externall wall
7	0.5	0.1	0.24	0.36	0.5	10	Northern House
8	0.8	0.05	0.63	0.48	0.7	7	Northern House
9	0.8	0.05	0.67	0.12	0.11	6	Northern House
10	0.8	0.05	1.47	0.49	0.36	6	Northern House
11	0.8	0.1	0.24	0.05	0.1	12	Northern House
12	0.5	0.1	0.25	0.05	0.04	7	Tower (cellar)

The report should also contain sketches with the collection points and photographic documentation.

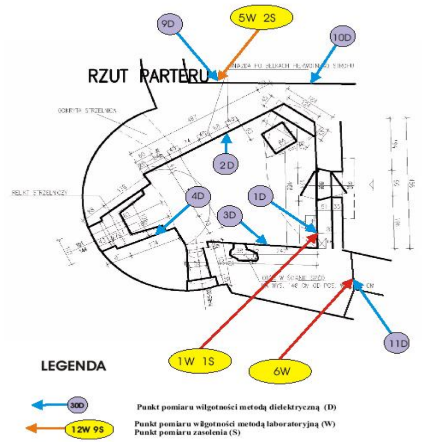

Fig. 14 Sampling points for tests on the ground floor of the defensive tower of the Janowiec castle

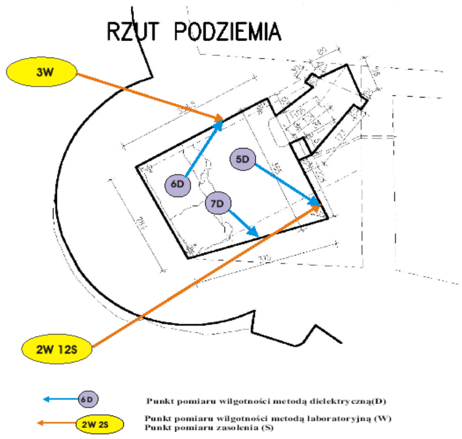

Fig. 15 Sampling points for testing in the basement of the defensive tower of the Janowiec castle

Depending on the scope and purpose of the research, it is possible to obtain a series of information not only about the degree of salinity of the surface layers of the wall. In the figures below examples of wall salt distribution profiles developed for different heights and depths are given.

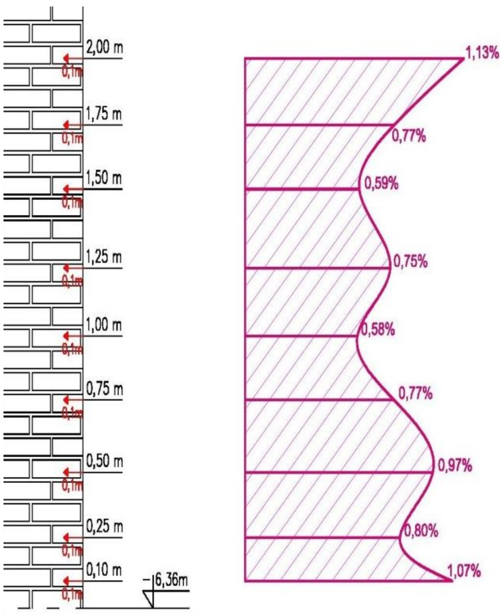

Fig. 16 Diagram of the distribution of salinity with sulphates at the level of the cellar wall at the sampling from the depth of 0.1 m.

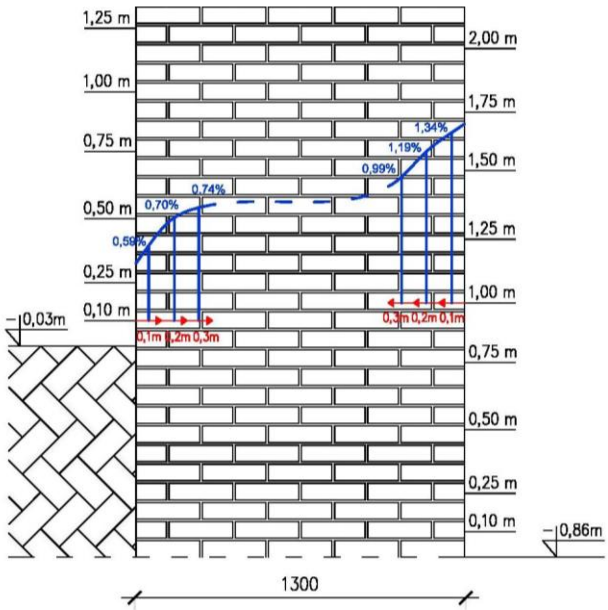

Fig. 17 Diagram of the distribution of salinity with sulphates of the external construction wall at the height of 0.1 m above the ground level.

3.3.4. Computer analysis

In order to determine the bearing capacity of structural elements, in addition to material testing, computer analyzes are also performed. Computer analyzes, in the case of monuments, are very complicated and are often erroneous. This is due, among other things, to the material inhomogeneity of the partitions and the inability to determine the material parameters necessary for the analysis (compressive strength, tensile strength, modulus of elasticity, etc.). On the basis of such analyzes it is possible to obtain stresses in the structure and to estimate its bearing capacity.

In historic buildings, computer analyzes are made for wall elements and ground. The subsoil is the basis for the structure and in the case of objects only this is analyzed. The analysis of phenomena occurring in soils is a very broad and complicated concept and is performed only in special cases.

Analyzes of masonry structures are performed more often. Masonry structures are composed of masonry material and mortar. This means that the wall is treated as a composite for the analysis of the structure. Depending on the complexity of the partition and its diversity, the final results are subjected to various errors.

In the case of a structure analysis by computer methods, the most commonly the FEM (Finite Element Method) method is used. This method can be distinguished by two general calculation approaches for the masonry model – one based on separate modeling of individual components, the other as a wall model made of a composite (one material with given parameters, without specifying masonry material and mortar).

The first method, also called the micro-modeling or heterogeneous modeling, requires a much more detailed modeling than the second method. It is necessary to determine the Young's modulus (modulus of longitudinal elasticity), the Poisson's coefficient and non-linear characteristics for wall elements and mortar. In addition, the contact zone should be appropriately modeled, which will reflect the joining of the masonry element and the mortar. The micro-modeling is applicable only in the case of small fragments of masonry.

A second method, called the macro-modeling or homogeneous modeling, is recommended for modeling the whole structure. It is a simplified method and there is no specification of masonry and mortar here. These types of solutions accelerate and simplify the analysis, however, significantly affect its detail.

It should be remembered that when performing computer analyzes, the optimal models should be selected to be effective – a sufficient analysis result should be obtained in the shortest possible time.

Bellow examples of the analysis of the masonry structure of an existing object using the first method – the heterogeneous are shown.

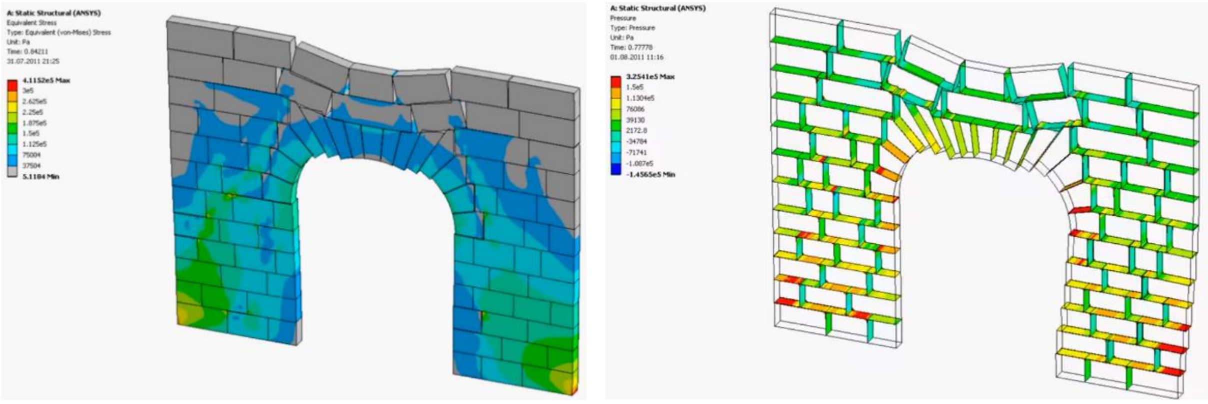

Fig. 18 View of stresses in a wall element and joints (*source: https://i.ytimg.com/vi/sMpNE9L2reY/maxresdefault.jpg*)

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4. REPAIRS OF HISTORIC RUINS

4.1 Repairs of masonry walls of historic ruins

To analyse the walls it is necessary to know their structure and construction. For different types of walls, a different nature of their destruction occurs and a different method of repair may be needed. Without a detailed diagnosis, it may not be possible to perform the correct project.

As is well known, the bricklaying accompanies the activities of builders almost from the very beginning of the buildings erection. Even in ancient times, structures from properly arranged stone blocks were erected. Over the next thousand years humanity gained new experiences in this field. At first, the knowledge of the building construction was passed down from generation to generation and had more of a craft character than engineering. In ancient times, erected constructions were the result of experience and practical knowledge of builders. The same applies to the masonry walls of buildings that are now in a state of the permanent ruin.

There were at least several ways to build masonry facilities. It depended on the builders and the availability of raw materials near the construction site. The most popular and, at the same time, the oldest walls are the masonry walls made of broken stone and stone blows joined using a lime mortar. In the construction of these walls, a material from local quarries was usually used. The parameters of these materials can be very diverse. There were many techniques for building masonry structures. However, the most frequent seen are walls made of stone blows and broken rocks. Sometimes layers were created in these walls with smaller, easier to process pieces of rock. In the case of walls of very large thickness, the walls called the "opus emplectum" were used. It was nothing more than making the external and internal face from the hewn block of stone, and then filling the space between the crumbled stone and the mortar. Later the brick was used as the masonry material.

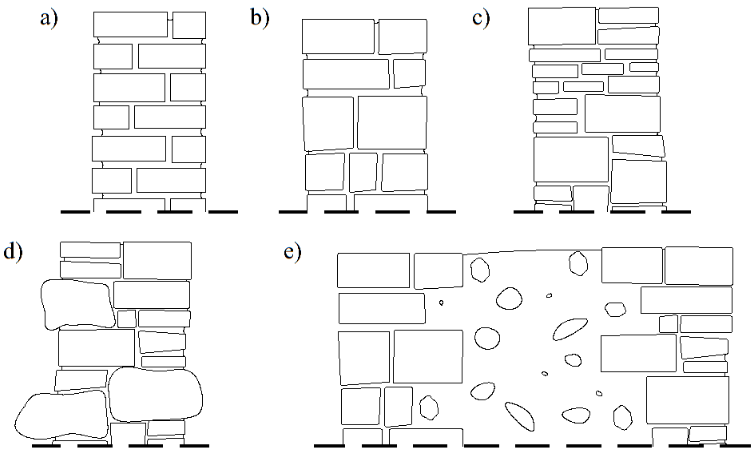

Fig. 1. Selected types of the masonry walls in the ruins of castles – a) wall made of ceramic bricks, b) wall made of stone blows, c) wall made of stone blows with leveling layers, c) wall made of broken stones with boulders, d) the „opus emplectum" wall[1]

It is often impossible to make computational analyzes of such walls. This is due to their irregularity, the inability to determine their internal structure and the exact physical parameters of the materials used. All kinds of works carried out are the result of experience of designers and builders.Only it is possible to perform approximate strength analyzes. The complete mapping of the construction behaviorwith such specific structureis very complicated and can give quite different results, even using modern computer methods.

4.1.1. Damage to the masonry wall's structure

The walls are constructed from small-sized elements connected with a binder. Like every element of the structure, they are damaged due to the excessive stress. Characteristic for the masonry structures is no susceptibility to deformation, unlike other constructions. All kinds of displacements in the structure result in the appearance of cracks and scratches. Not all wall's damages endanger the safety of its use, however, all defects are a sign of irregularities in the performance of wall elements.

To start the correct repair work, firstly, diagnostics should be performed. The diagnostics itself should start with the analysis of the archival documentation and the conditions of the construction operation. Information about earlier reinforcements, repairs, and works carried out related not only to the damaged element but also to the whole building can be crucial in the search for the causes of damage. It should be remembered that removing the consequences of a failure without identifying and removing its causes may be the pointless and short-term treatment.

While making a diagnosis, it is necessary to correctly determine the damage and analyze the external factors that can cause it. The close linking of effects to causes will significantly reduce the scope of the search area.

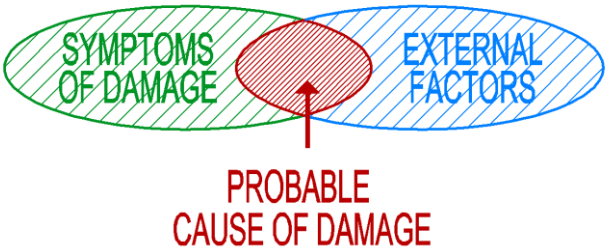

Fig. 2. Scheme of determining the cause of the damage

After finding the common part of causes and effects, a preliminary diagnosis should be made, which should be confirmed by research or structural analysis. Only after confirming the initial diagnosis there is possibility of proper selection of repairs.

4.1.1.1. Causes of damage to the masonry wall's structure

Defects arising in the construction of the masonry walls are usually determined by the condition of the wall itself. It may be possible to exhaust the load bearing capacity over time due to changes in physical parameters of materials. These changes are most often caused by the degradation of their structure. The structural degradation occurs due to external factors and related processes. The main reasons for the destruction of structural elements are:

- freezing and thawing of water bounded in the structure of the wall elements,
- crystallising salts, which are present in the structure of materials,
- erosion of masonry materials due to the effects of wind,
- development of biological corrosion due to the excessive moisture.

Strong degradation of the masonry material is usually the first stage of the structure's damage and significantly contributes to the start of the remaining stages (the appearance of cracks and scratches). As a rule, there are more factors in the destruction process. Firstly, slow and gradual destruction begins, and then as a result of the weakening of the structural elements, their susceptibility to deformation increases.

Photo9. Degradation of the wall due to the environmental factors /Międzygórz castle/

Photo10. Cracking of a masonry material /castle in Rabsztyn/

Photo11. Damages of the "opus emplectum" wall (photographer - Marek Krysiński) /Międzygórz castle/

In the case of buildings erected today in accordance with [2] to structural damage of the masonry walls most often occurs as a result of the foundations settlement (up to approx. 60-70% of all cases). Definitely less, because only 15-20% of damage is caused by exceeding the load bearing capacity of the walls, and it takes place mainly in window pillars or arcade pillars. Other damages are the result of thermal loads, dynamic loads, and exceptional loads. In the author's opinion, these statistics can also be applied to the permanent ruin objects, bearing in mind that to the appearance of scratches and cracks usually occurs after significant degradation of the wall itself.

4.1.1.2. Characteristics of the masonry walls' defects

Usually, on the basis of damage (mainly cracks and scratches) it is possible to determine the reasons for their formation. To clarify these reasons, an analysis should be made and the morphology of their creation should be investigated. The situation can be much more complicated if the influence has more than one factor. The typical defects of the structure and their division with regard to the factors that cause them are presented below.

- **Uneven settlement of soil under foundations** – by far the most common cause of damage to the masonry structures. Depending on the way the foundation settles, the cracks may have a different course and character. Defects in structures always arise in the most strenuous places – those in which the stresses in the material are the greatest. These stresses will have a diversified distribution, which depend not only on the part that deforms ("settles") but also on the proportions of the structure's elements (width, height, and thickness), proportion, type of the wall elements, number of holes, previous damage, and even earlier repairs. Exemplary, ideological stress distributions are shown in Fig. 3 as pressure lines in the masonry wall. In addition, places were also marked where scratches and cracks appeared.

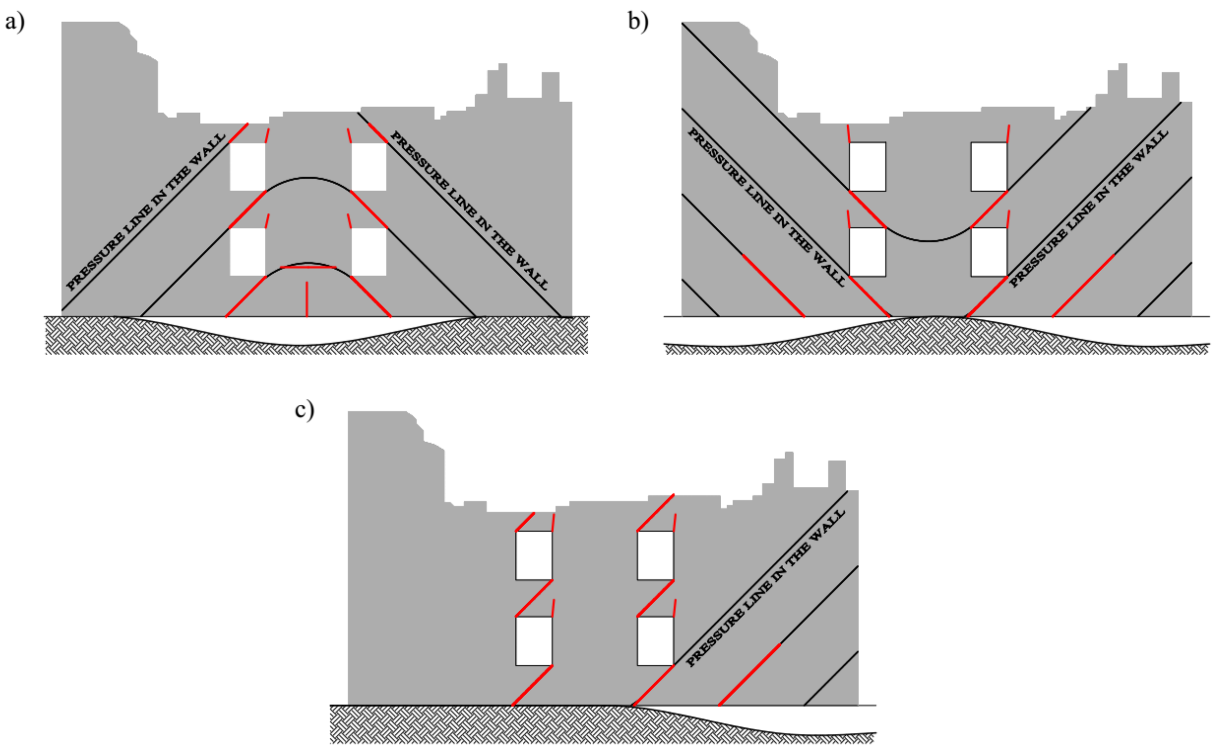

Fig. 3. The ideological course of the pressure line and damage in the wall due to: – a) settlement of the central part of the wall, b) settlement of both wall corners, c) settlement one of the corners [3]

After making a preliminary diagnosis of the wall cracks caused by the settlement, it should be confirmed by conducting appropriate tests by an authorized geotechnician. First of all, the soil boreholes should be made in the places where the damage appeared. Next the comparison with the previous results or with the parameters of the land, on which no damage occurred should be performed. The settlement phenomenon can also take place as a result of the rise of the groundwater level, which should also be checked.

Diagnosing whether consolidation has taken place in the soil can be a complex, time-consuming, and expensive task. If it is not possible to unambiguously confirm the change of soil and water parameters after performing basic tests, it is necessary to carry out tests in the extended scope with the use of specialized equipment for the soil diagnostics. Then all soil parameters should be determined in the laboratory. It is also recommended to prepare a detailed subsoil documentation.

In addition, in the case of this type of damage, permanent monitoring of the structure is recommended in order to determine whether the processes that occurred were only the one-time rockbursts or if the structure is constantly deforming. The construction monitoring can be performed using geodetic methods or commonly available feeler gauges.

Photo12. Damage caused by uneven settlement /Krzyżtopór castlein Ujazd/

- **Excessive vertical loads (parallel to the wall's surface)**– this is a much rarer situation in the case of the masonry facilities, and even rarer in the case of the permanent ruin masonry buildings. Due to the very large thickness of the masonry walls in the objects of the historic ruins, the walls have high strength parameters.

Exceptional situations may be situations in which the following occurred:

  - damage to a fragment of the wall (change of the static scheme or its slenderness),

- increasing the loads transferred to the wall caused by changes in the operation of the facility,
- significant corrosion and degradation of elements of the masonry structure that negatively affect its physical properties.

The phases of destruction of the brick wall are shown below in Figure 4. In the case of constructions made in another technology, the destruction phases will be similar.

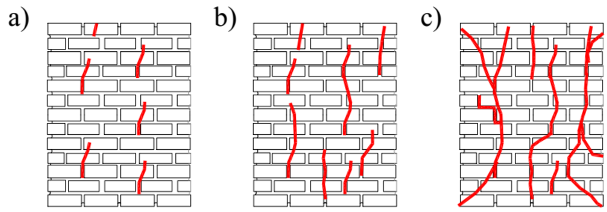

Fig. 4. Phases of the wall destruction: a) first phase – appearance of small cracks, b) second phase - widening of cracks, merging of cracks and appearance of the first scratches, c) third phase - connection of scratches and cracks – the construction failure [4]

The first phase of destruction of a masonry structure does not threaten the safety of its use, however it may herald further damage to the element. It is therefore a signal of the possibility of danger when the loads will be increasing or steps are not be taken to repair or strengthen the structure. After observing even small scratches and cracks of a character as in Fig. 4, a permanent monitoring of the structure is recommended. Using the simplest feeler gauges, gypsum seals or glass plates, information will be received whether it is subjected to further damage, and whether it is possible to move to the next phase of the wall destruction. The next phase may already threaten the safety of the facility's use. In the event of the second or third phase, immediate steps should be taken to secure or reinforce the structure.

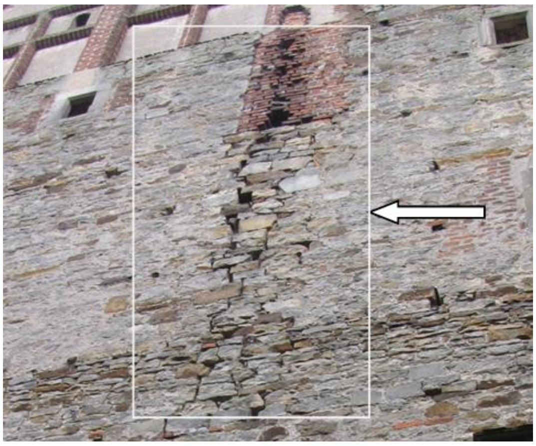

Photo13.Damage to the masonry structure /castlein Drzewica/

- **Excessive horizontal loads (perpendicular to the wall's surface)**– damage due to excessive horizontal loads occurs mainly due to the effects of wind or inadequate use of the object. As unsuitable use, it is understood that the walls are loaded by covering with soil or disturbing the balance of forces by, e.g., digging out an underground part of the wall on one side only. In the case of objects in ruin, walls with a significant slenderness (e.g., slender attic) are exposed to external loads.

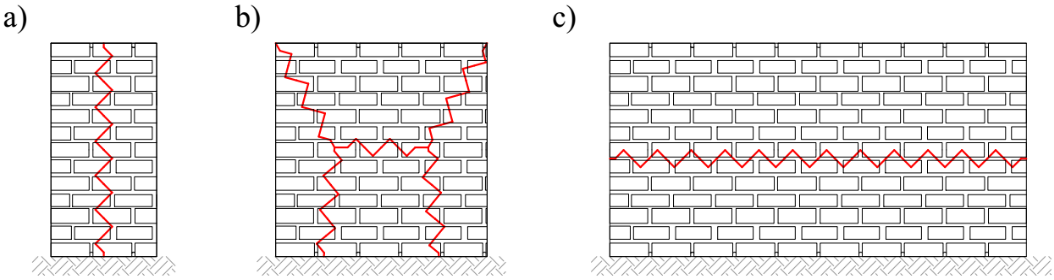

Fig. 5. Damage to the brick elements caused by excessive horizontal force (perpendicular to the element's plane) depending on the proportion of the element: a) slender elements, b) similar height and length, c) elements with a significant length in relation to the height [2].

In the case of appearance of similar cracks, as in previous cases, the permanent monitoring of the structure should be carried out, and in the case of free-standing elements, also geodetic surveys of the wall's verticality should be performed.

Photo14.Examples of cracks in a slender attic wall /castle in Drzewica/

- **Cracks in the corners of the holes** – due to the nature of the stress propagation in the elements, the stress concentration always occurs in the holes' corners (stresses have the highest values there). Scratches or cracks originating in the convex corner do not necessarily mean the damage to the wall structure in the immediate vicinity of the visible defect. Appearing cracks and scratches, however, are a clear signal that the structure could have unplanned deformations and subsequent damage may appear elsewhere and could be more dangerous in its effects. As a rule, single cracks appearing in the corners of the window openings with not considerable length and width are not direct threat to the structure's elements.

The only exception is the situation where the window head itself has been damaged. The window head damage may occur due to the exhaustion of its load bearing capacity caused by an excessive load or corrosion, and destruction of the materials from which the window head is made. Depending on the window head's type, the cracks may have a very different course. In the case of arched window heads, the damage is usually perpendicular to the arch, while in the case of flat window heads –directed towards each other (Fig. 6).

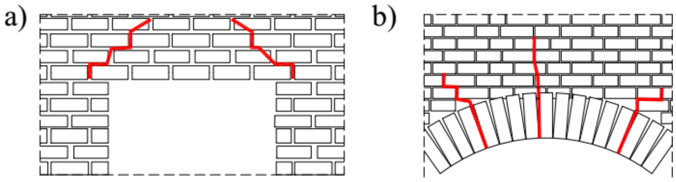

Fig. 6. Damage to the window head's elements: a) flat window head, b) arched window head

These defects should be constantly monitored, in the same way as in other cases.

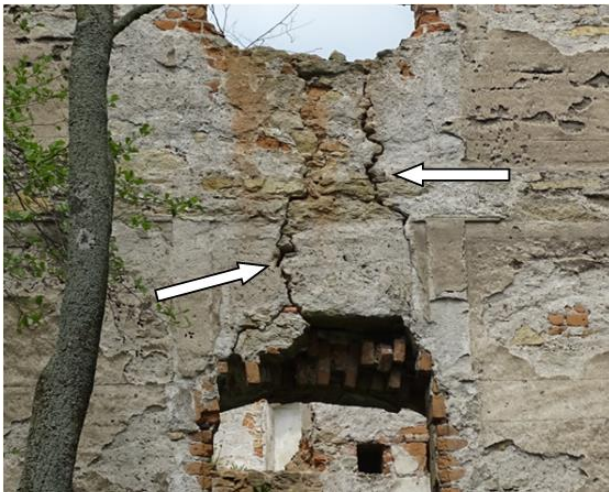

Photo15.Example of the window head's damage /Panków castle/

4.1.2. Repairs of the masonry structures

There are a lot of repairs methods to damaged masonry structures. It should be remembered about the specificity of the historic buildings, and in particular the permanent ruins. The ruin buildings usually have little materials, so in their case, further depletion of a historical material could have a negative impact on the reception of the monument itself. Below, has been presented and briefly described the repair works of the masonry walls, which were assembled on the basis of completed, analyzed construction and executive projects, interviews with users and managers, and a local vision on nearly 50 permanent ruin buildings in Poland and abroad. The repair method depends mainly on the scale of the element's damage.

The most commonly actions performed during reinforcing masonry structures are included:

- **Rebuilding of the structure's fragments** – very often used and in some cases the only possible method. The fragments of the wall should be rebuilt in the case of highly damaged walls, severely degraded or so damaged that all other methods are not justified technologically and economically. With the help of rebuilding it is possible to almost completely get rid of the damaged material, and replace it with a new material – completely healthy. Unfortunately, this treatment is associated with the depletion of the historical material in the element itself. There are situations in which it is possible to rebuild or supplement a damaged part of the wall with historical material originating from another part of the building, however, due to the high value of such material and often insufficient technical condition, these are rare situations.

Before proceeding with the rebuilding, an appropriate technical documentation should be made with the determination of the technology of conducting the works. The procedure itself may seem relatively simple, but its unskilful performance may result in negative consequences in the further operation of the facility. Materials used for the rebuilding process should be chosen by a suitably qualified person. The selection of not suitable materials (e.g., a cement mortar or too strong masonry material) can lead to acceleration of the masonry degradation process or even its complete destruction.

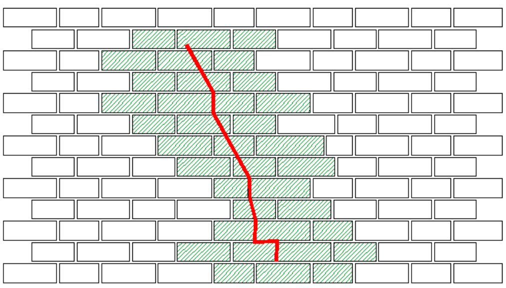

Fig. 7. Scheme of the wall rebuilding

Photo 16. Fragments of the wall rebuilt /castle in Janowiec/

In the degraded element, not only the damaged parts should be rebuilt but also elements in the immediate vicinity. This will ensure better cooperation and binding of the wall's construction.

- **stitching the walls with steel rods** – one of the most frequently used methods of the masonry repairs. Stitching the walls finds its application in cases when the damage is not so large that it would be not reasonable to completely rebuild the wall's fragment. There are currently many system solutions for this type of repairs. All these solutions are, in principle, very similar or even identical. They consist in the introduction of a steel element, which is often a stainless steel rod in the joint or in a pointed incision (in the case of walls with an irregular joint, it is allowed to cut the structure) that is perpendicular to the crack's direction. The reinforcement introduced takes over the tensile forces that previously contributed to the damage of the structural element. It should be remembered that if the cause of cracking will not be removed and the local wall reinforcement will be made, a situation may occur in which the damage may appear on another part of the wall. The local repair strengthens a fragment of the wall and the stresses occurring in it can damage other places with poorer physical parameters.

The wall stitching is carried out by making a cut or crushing the joint to a depth of usually about 3-4 cm. The joint should be properly cleaned with compressed air, and then moistened so that it does not absorb water from the repair materials, which is necessary for the hydration processes. After cleaning, a primer preparation (about 1-2 cm) should be introduced into the joint. Then, in the joint and the unbinded primer preparation a system steel rod is introduced. Information on the type, diameter of the rod, vertical spacing, and a furrow's width are dependent on the nature of the damage. They should be included in the design documentation.

An exemplary scheme for repairing a cracked wall using system bars is shown in Fig. 8.

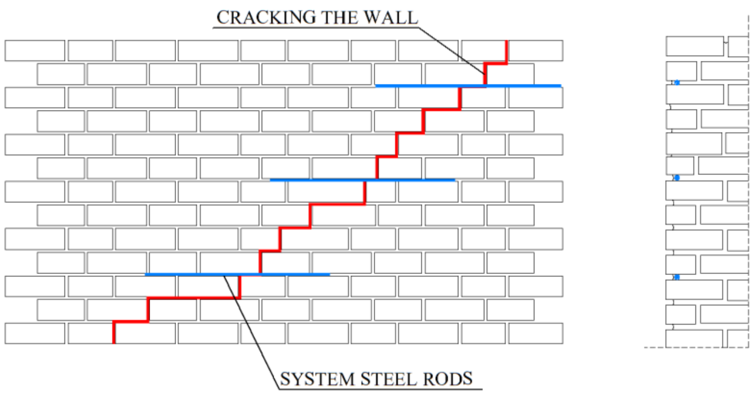

Fig. 8. Scheme of the wall's structure repair by using system steel rods

- **repair by the FRP tapes** – the method, which is very similar to the method of stitching walls with steel rods. The principle of repair is very similar. It involves removing a part of the wall's face or making a furrow in the wall's fragment. Then the FRP system tapes (carbon fiber tapes) are assembled using a mortar or system glue in a furrow followed by restoring the wall's face or making grouting. The widths and lengths of tapes are varied, which depend on the damage. As in the case of stitching walls with rods, these parameters should be included in the technological project. However, strict adherence to the technological regimes is necessary. This applies to the preparation of the substrate, which must be sufficiently strong and free from major unevenness so as to preserve the adhesion of the introduced element.

- **nailing** – the method is mainly used to stabilize walls of large thickness (most often erected in the "opus emplectum" technology). Strength parameters of the masonry structure, after its delamination, are significantly reduced. Deterioration of these parameters may result in further damage or even failure of the entire structure. To prevent the walls' delamination, various types of anchors are used. As a rule, these are steel anchors, sometimes with retaining elements (blocks, sheets, special shapes). The anchors are inserted into the pre-drilled holes filled with injections causing adhesion to the material. Depending on the wall's type and the technology chosen, mainly resin or mineral injections (microcementes, special cement pastes) are used.

- **nailing with meshing** – a method similar to the traditional nailing, with the difference that a steel mesh is also installed for reinforcement or protection purposes. Steel mesh can be made and fastened mainly in two ways. The first consists in the appropriate furrows making, and then the embedding of the pre-prepared mesh and restoring the joint (embedding technology is identical as in the case of the stitching method). The second method applies only to the protection of the wall's face. Between the anchors and the face of the wall, a steel safety mesh is mounted (photo 6).

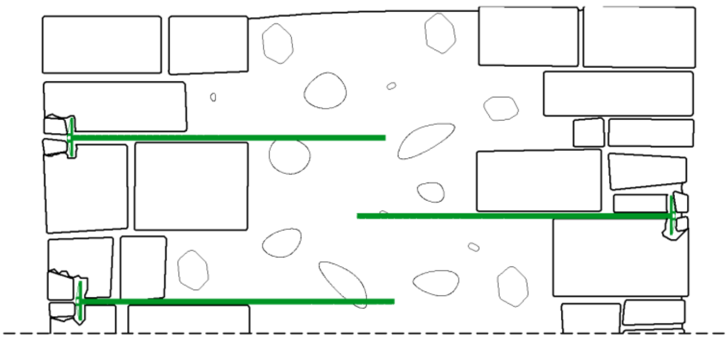

Fig. 9. Scheme of nailing with the supplementation of the wall's face of the „opus emplectum" type

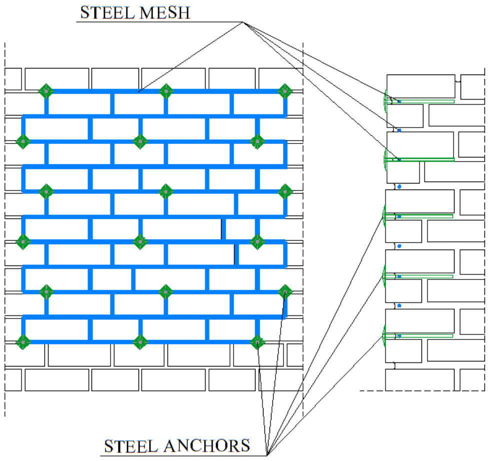

Fig. 10. Scheme of the wall's repair using an anchored steel mesh

Photo17.Protection of the damaged wall's face with a steel mesh mounted by the anchors (photographer - Grzegorz Basiński)

- **injection into cracks and scratches** – consists in inserting the injection solution into the very narrow slits. It is important that the modulus of elasticity of the preparation should be significantly greater than the material being repaired that no secondary dilatation-like cracks occurred. The strength of the material should not be less than the strength of the masonry material – the combination of the injection with the wall elements should monolithise the structure. Depending on the width of cracks, stabilization of the structure, and its moisture level, various types of injection materials are used:
  - In the case of cracks with a width of less than 0.3 mm, only resin injections may be used; in the case of the cracks' widths of 0.3-0.5 mm, it is also allowed to use the microcements and cement pastes. In the case of cracks with significant widths (larger than 5 mm), in addition to injections, it is also recommended to perform wall stitching with the steel system rods.
  - In the case of unstable elements (continuously deforming) it is acceptable to use only flexible resins.
  - In the case of dry cracks and the application of injections made with cement pastes or the microcements, the joint must be moistened in advance.

Photo 18. Injection into a crack with a cement mortar (photographer – Sylwester Zieńczuk) /castle in Liwa/

4.1.3. Summary

The walls of the permanent ruin buildings are very specific. The building solutions used in them are not typical today. It forces both designers and contractors to properly prepare substantive and technical content before starting a repair. In addition to the complexity of repair procedures, it is also important to respect the historical value and perform treatments only in accordance with the conservation doctrine or issued guidelines.

The analysis of the causes of damage and the ways of their repairs showed above all that this is not a marginal problem, but the issue very often is taken into account in technical studies regarding the permanent ruin. Due to the specificity of the buildings and the application of formerly common and diverse solutions to their construction, each case and object should be treated individually. Based on local visions, interviews with users, and analyses of the documentation collected, it was founded that it was not possible to create a repair algorithm that would check each time.

4.1.4. Literature:

Footnotes

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4.2 Repairs of wall crests

A characteristic feature of objects in the state of the so-called permanent ruin is a great number of detached walls. They comprise both the historically detached walls and the walls of the primarily cubature (or : volumetric) objects. The constructions , devoid of protective elements, are specially exposed to the danger of degrading factors activity. Due to that fact, the destructive processes are clearly faster here and the negative effects have a wider range than in the case of other objects. Certainly the biggest destruction has been observed at the wall crests, i.e. the part covering the lower parts of the walls, that is why it is so important to secure them properly.

4.2.1. Characteristic features of ruined wall crests

The state of the objects preserved as the so-called permanent ruin is a resultant of many processes taking place in those objects during the course of years. The most important ones are: materials and constructions of which they were erected, the time from their construction and the moment when they went to ruin, the factors responsible for the process of degradation, and the damage brought about by the man.

Analysing the castle objects in the state of permanent ruin one may introduce a full range of typologies determining the form in which the walls have been preserved up to our times. The current article suggests the division based on the dimensions (height and width)and the shapes of the crests surmounting the walls.

The wall height. It happens quite often, that there are high, medium and low walls within the confines of one object. The division is certainly purely conventional and refers to the primary height of the walls and their actual height is concerned with the grade of destruction. High walls are those that have been preserved practically in an unchanged state. Their historical line has been preserved and the destruction traces are really scarce. The width of the crests and their profile is largely authentic. The most frequently appearing walls are certainly the middle ones whose height and the shape of the crest has been changed radically as compared to the primary one. The walls of medium height are those, that have lost a significant part of their upper portions, the line of crenels , shooting platforms etc. is not clearly seen. Due to the original cross-section, growing broader towards the lower parts and reducing the height of the wall , their crests are significantly wider than it is in case of high walls. The activity of the atmospheric factors makes the profile of the crests highly irregular. Another group consists of low walls which have been preserved up to our times as relics. There are , in fact, only remains of walls, slightly protruding above the area , leveled with it or even lower.

Thickness of the wall. The second, rather legible criterion of the division of walls in ruin is their volume. We can differentiate thin and thick walls. The division results, first of all, from the primary function of the object . Thin walls are mostly the relics of the earlier volumetric objects and the fragments of inner walls that did not perform the historically defensive function. Thick walls are most often the outer walls of the castle, the curtain walls and the inner walls of the object that are the remains of defensive objects (towers , turrets, etc.). In a prevailing part of objects, due to the degradation processes, there are no preserved up to the present moment thin walls of the form, and they are presently totally illegible or preserved only as relics.

The shape of the crest. Another category is the shape of the wall crest. We can differentiate walls of regular crests slightly deflected from the level. The leveled line of the crest may result from the natural processes (taking into account the homogenous building material and the same primary dimensions, the processes looked similar), or may be the result of the contemporary works carried out at the object. Another group consists of walls with crests of irregular heights. The predominant part of this group is the group of walls of the primarily volumetric objects. They were often endowed with numerous doors and windows. After the destruction of the upper part the wall is left with the characteristic protruding remains of the inter-window pillars . The irregularity of the crest lines may also be caused by the conscious activity of man or result from the damages that have taken place in the object.

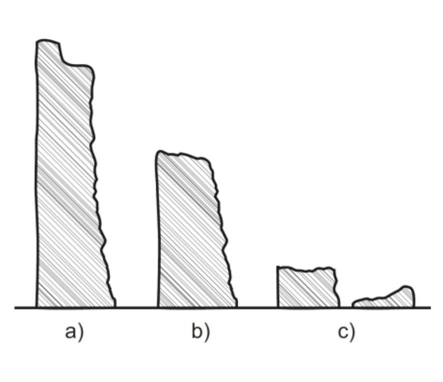

Fig. 1 The division of walls with respect to height: a) a high wall, b) a medium wall, c) a low wall

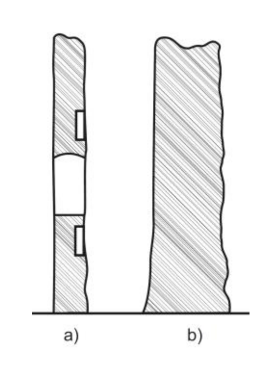

Fig. 2. The division of walls with respect to thickness: a) a thin wall, b) a thick wall

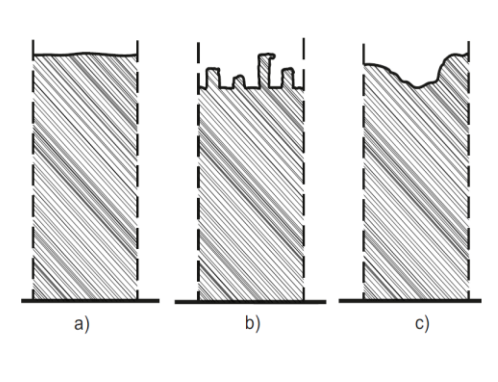

Fig. 3. The division of walls with respect to the crest shape: a) a wall with a leveled crest, b) a wall of a volumetric object window openings, c) a wall with an irregular line of the crest

In the predominant part of the objects the walls of all the described categories were preserved. It results from the primary variety of dimensions, reconstructions carried out in various techniques and a variety of the materials used. The securing solutions which are being carried out should take into account also the geometric form of the preserved walls. There is a photographic documentation below of various types of walls of the objects in ruin.

Fig. 4 A massive defensive wall. (The castle of Janowiec on the Vistula River)

Fig. 5. A massive defensive wall with a high parapet.(The Castle of Bolków)

Fig. 6 The wall of the primarily volumetric object. (The castle of Międzygórze)

Fig. 7. The wall of the primarily volumetric object. (The castle in Czorsztyn)

	
Fig. 8. The Wall of the primarily volumetric object. (The Castle of Pokrzywno)	Fig. 9. The Wall of the primarily volumetric object preserved as a relic. (The castle of Janowiec on the Vistula River)
	
Fig. 10. The Wall preserved as a relic. (The castle in Iłża)	Fig. 11 The relics of the castle intermural space. (The castle in Bobrowniki)

4.2.2. Degradation of the wall crest

The quality of the construction material has the greatest influence upon the character and dynamics of degradation of the wall crest. These are the physical, chemical and mechanical properties of stone, brick and mortar that affect the durability of the historical crest or the employed security solutions. The very degradation is mostly dependent upon three factors: environmental ones concerned with the climate (humidity, temperature changes, solar radiation, wind), chemical (activity of the chemical compounds inherent for the walls and provided from the outside – aggressive fluids or salts), biotic (activity of microorganisms, fungi, moulds and plants). Explanation of the mechanism of wall degradation is relatively difficult and it requires the knowledge of the progress of particular processes responsible for corrosion and the interdependencies among them.

The predominant part of the degradation processes is strictly related and to a great extent dependent upon excessive humidity. Intensification of the phenomena connected with salt corrosion, frost and biological corrosion results from the increase of the amount of water in the area of the wall crest. Thus it is water that influences most – directly and indirectly – the processes of degradation of brick, stone and mortar. The process is caused, first of all, by the rain water that appears on the surface of the crest when it is raining and then proceeds inside the wall. The rain water soaks through the wall and during the first stage causes dissolution of the binding agents of mortar, damage of the media and then, their complete destruction. As a consequence, the carrying capacity of the parts of the wall devoid of mortar become lower. In case of low walls there is an additional problem of ground-water that may be drawn upwards by the capillary mechanism and the result of the process is a similar degradation as in the case of rainwater.

Humidified materials are destroyed faster also due to the cyclic process of freezing and melting of water contained in the pores of the material and in the wall caverns It increases its volume when freezing which causes the destruction of the material. Degradation caused by the, so-called, frost damages is especially clearly seen at the south elevations of the objects due to the multiple repetitions of the processes of freezing and melting during one season.

Other factors directly related to humidity are the corrosion processes caused by salt. The destructive activity of salt may be multiple. While the solution of salt is constantly transported, its crystallization is accomplished on the surface of the element. Thus, we might say that the immediate threat of destruction is less imminent, but the aesthetic impression of the surface of the material is much worse. Various types of salt on the surface of the material may crystallize in the form of blots, damp patches, efflorescences, fluffy deposits and glassy envelopes. The form depends upon the kind and amount of salt and also the conditions of crystallization. In the situation when the velocity of providing the solution is smaller , the temperatures outside are high, the evaporation range moves deeper inside the wall and crystallization is accomplished in the surface layers of the material. It is good to remember that the salts following the process of cristallization in pores and capillars or at the surface of the element are still easily soluble. In case when they are provided with a necessary amount of humidity they pass on to the solution and when the conditions are changed, they crystallize once again. This is especially clearly seen when there is a significant salinity on the outside of the object. The process may be repeated many times, even a dozen or so, dependent upon the atmospheric conditions, causing more and more degradation.

Biological corrosion, also called biodeterioration is understood, in construction, as varied forms of destruction of the elements of a building caused by the activity of living organisms i.e. biological pests. They are mainly green plants, dry rots, mildew fungi, insects, algae, lichens and bacteria. Like in the case of salt the condition of occurrence of most of the above –mentioned organisms is humidity and its increased level is responsible for the intensification of the corrosion processes. The appearance of even a minimal portion of humus in the wall cracks and on top of the crest results in the growth of green plants. At the beginning the dominant plants are mostly small annuals or biennials and grasses. Their growth is particularly intense at the points of greater humidity . Decay processes cause the appearance of humus acids in the wall as well as the increase of the amount of nitrates. Later on, along with the growth of the humus layer (decay of plants, blowing in soil), there are more perennials, bushes and trees. The results of growth of higher plants are similar as in the case of lower plants, additionally there is the danger of the roots growing into the walls. The developing root system (usually growing into the mortar junctions) causes the stratification of the wall leading to a serious degradation.

The above described degradation factors and the degradation processes that imply them practically never appear separately. The state of the crests of the ruined walls is most often caused by all of them or almost all. The photographs below present the degradation of the wall crests pointing out the main degradation factor.

Fig. 12.Degradation of the crest of a stone wall constructed of a really durable material caused by the effect of rainfall and snowfall.

Fig. 13. Degradation of the crest of a ceramic brick wall caused by the effect of rainfall and snowfall

Fig. 14. Degradation of the crest of a stone wall constructed of a low durability material caused by the effect of rainfall and snowfall

Fig. 15. Degradation of the wall mortar with a good preservation of the wall material.

Fig. 16. A significant amount of annuals and perennials causing the degradation of the crown and the loss of legibility of the wall outline (contour).

4.2.3. Methods of protection of the wall crests

The works securing the wall crests are usually connected with a partial or complete wall reconstruction. The method of securing the crest is selected with respect to the assumptions of the conservation program. The particular methods of securing the crests are characterized by different durability, legibility and reversibility of their use. The solutions aimed at securing the crest against the degradation factors are dependent from: the type of the wall – the form in which it has been preserved up to modern times, the type of construction and the materials that were used, the state of its preservation, the overall architectural concept for the whole object and the concept of the conservation works. The methods of securing of the wall crests can be divided into two groups.

The first one assumes constructing a new, additional layer on top of the historical wall. According to the assumption it is a layer which may be degraded and in case of degradation it should be cyclically reconstructed. The group includes: reconstruction of a part of the walls, addition to an existing masonry wall, securing the crests with mortars or concrete or a soft capping method.

The second group includes methods which aim at covering or protecting of the historical tissue from the influence of rainfalls or snowfalls. This kind of solutions may be either temporary or durable. The group includes: roofing, securing the crest with sheet metal and chemical coatings.

In all those cases the prior reconstruction of the degraded historical wall is necessary to a smaller or greater extent. The most frequently employed solutions that have been described below aim at securing the wall crests in the objects left as permanent ruin.

- Reconstruction of a part of the walls

Certainly the most efficient solution aimed at the durable securing of the wall crest is the partial reconstruction of the object. Reconstructions may vary in character and they are precisely connected with the concept of architectural works concerning the whole object. Contrary to addition to an existing wall where the height of the new construction of the wall is rather small (several dozen centimeters), in case of reconstruction the new fragment of a wall can even be several metres tall. It is usually the native material that is used in reconstructions, varying only in color, the size of the wall elements or the technology of mortar pointing. In the objects with reconstructed walls one can observe various methods of finishing the new crest. It depends upon the function that is to be performed by the object, or the vision of the design author. It is possible to single out three groups of such reconstructions:

- Walls reconstructed up to their historical height, with the defensive architectural elements, i.e. crenellations, parapets, ramparts, roofing, etc.
- Walls reconstructed lower than their primary height, with a straight finish of the line of the crest, with or without an additional roofing,
- Walls reconstructed lower than their primary height, preserving the kind of plasticity characteristic for the objects defined as permanent ruin.

Fig. 17 . Reconstruction of substantial fragments of the wall with the material compatible with the historical one. (The castle of Inowłodz)

Fig. 18. Reconstruction of substantial fragments of the Wall with the material compatible with the historical one. (The castle of Łęczyca)

Fig. 19. Reconstruction of substantial fragments of the wall with the material compatible with the historical one)

- Addition to an existing wall

Construction of additional layers of the wall with the use of native or foreign material. It is the basic, simplest and most frequently employed conservation measure aimed at the protection of the monumental substance of the wall crest. It consists in making up for the losses in the upper part of the wall and giving the suitable shape to the wall surface. The very addition to the wall does not stop the process of the crest degradation, but it shifts the degrading activity to the new material, consciously provided for a temporary exchange. An extremely important thing is the proper choice of the wall material and the types of mortar in order to prolong the time of functioning of the construction securing the wall and prevent the situation when the newly introduced materials could be a threat for the historical ones.

Additions are made with the use of native or foreign materials. In case of native material it could become a problem, in the course of years, how to differentiate the additions. In the case when the additions are made of foreign materials, visibly differing from the old ones, the secured crest looks unnatural and one cannot resist the impression that the solution is artificial. Undoubtedly an advantage of addition to an existing wall is the possibility of unrestrained shaping of the wall crest which allows to obtain the plasticity compatible with the historical one. Additions are made after the introduction of one more isolation layer, or directly upon the historical material. Certainly a better solution is the use of isolation. It allows supplementary securing of the ancient wall and at the same time as a dividing layer it makes the solution reversible.

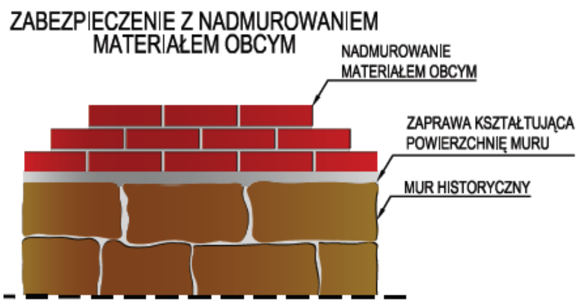	
Fig. 20 Addition made of foreign material /A securing layer – addition of a foreign material/ Addition of a foreign material/ Mortar giving shape to the wall surface/ The historic wall	Fig. 21.Addition made of foreign material without the isolation layer. (The castle in Janowiec on the Vistula River)

	
Fig. 22. Addition of the crown made of contemporary brick, on a type of mortar stronger than the original one.(The castle in Bobrowniki)	Fig. 23. Addition of the material compatible with the historical one combined with the isolation of sheet metal

- Securing of the crest with mortar or concrete

  The method consists in making a tight layer of mortars or concretes upon the degraded wall crown. The kind of securing is made directly upon the historical tissue or the isolation material that is assumed to be a dividing layer which allows a simpler removal of the securing layer without the destruction of the historical wall. Plasticity of the material used for securing of the crest allows the shaping of inclinations leading the rainwater flow out of the object or into it. One of the greatest advantages is the possibility of obtaining the form of the wall crest compatible with the line formed by the natural factors. The mortars which form the securing layer should be as tight as possible, so that rainwater should not permeate the securing layer and in case when there is no isolation, infiltrate into the historic layers. In case of low walls this kind of securing may be perceived as not really aesthetic.

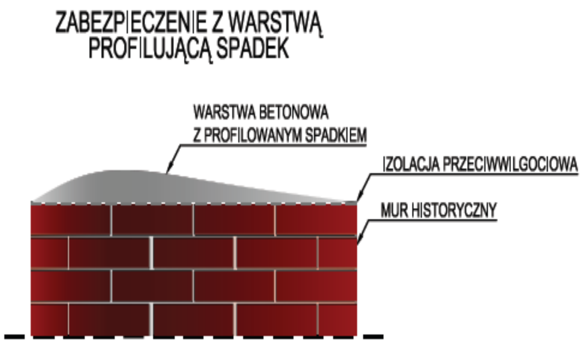

Fig. 24 . Crest molding with mortar or concrete./ Securing layer with a molded inclination/ Concrete layer with a molded inclination./ Isolation protecting against humidity/ Historic wall.

Fig. 25. The crest secured with a layer of cement mortar – without molding. (The castle in Rawa Mazowiecka)

Fig. 26. The crest secured with a layer of cement mortar – with molded inclinations.(The Castle in Kurzętnik)

Fig. 27. The crest secured with a mortar layer – with molded inclination.(The castle in Bodzentyn)

- Soft capping

  Introduction of a layer of plants upon the wall crest after its previous preparation (with or without isolation, addition to the wall and molding the inclination). The method consists in the intentional covering of the crest with a layer of fertile soil and planting dwarf plants, usually the shallow-rooted grass. This kind of solution is very rarely used because of a whole range of restrictions. The crests secured with soft capping must be supplied with an addition and leveled ,which causes the change of the crest plasticity. Vegetation growing on the crest requires some kind of cultivation which makes the access to the crest necessary. Quite a thick layer of humus allowing grass vegetation, creates also a possibility of seeding and growth of undesirable vegetation (perennials, bushes and trees.)

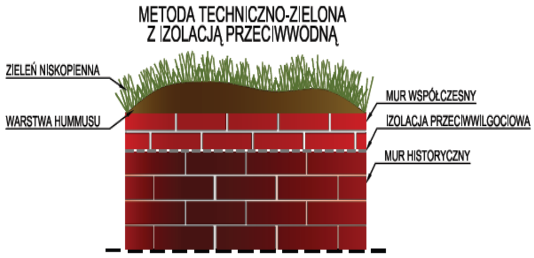	
Fig. 28. Soft capping./Soft capping with isolation preventing the activity of water./ Dwarf vegetation/ Layer of humus / A contemporary wall / Isolation preventing the activity of water / Historic wall /	Fig. 29. Soft capping securing the castle wall crest. (The castle of Toruń-Dybów)

- Various types of roofing
  They are not usually a very aesthetic solution, but a durable and reversible securing of the wall crest against the rainfalls. The types of roofing usually made can be divided into two groups. Most frequently the roofing is made as a temporary one, covering the particularly degraded or threatened with degradation portions of walls as well as permanent constructions over the passages allowing to walk upon the crests. In case of temporary solutions one can observe a certain freedom of choice of the materials used and the construction solutions. A permanent roofing , as to the form and material, may be referring to history or completely modern.
  - Made of small elements (ceramic or concrete tiles or slates) upon a layer of mortar placed on the crest.
  - Made of sheet metal or laminate fixed on the wall crest.
  - Made upon the supportive constructions without a permanent fastening of the covering material to the historic tissue.

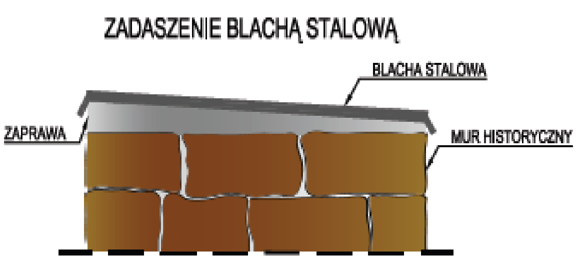	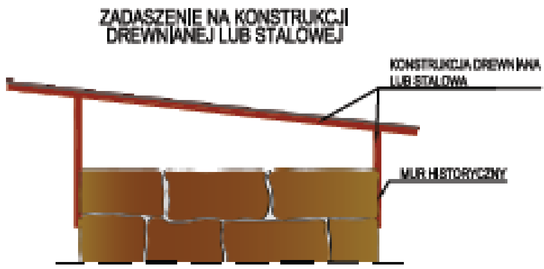
Fig. 30 Roofing of a steel sheet with a layer of molding inclination. / Roofing with steel sheet / Steel sheet / Historic wall/ Mortar/	Fig. 31. Roofing with the use of woodem or steel construction. /A wooden or steel construction / Historic wall/
	
Fig. 32. A steel sheet roofing of the wall crest made directly upon the wall (The castle in Janowiec on the Vistula River)	Fig. 33. Securing of the crest and a detail by a wooden construction with corrugated sheet metal (The castle in Janowiec on the Vistula River)

- Securing the crest with sheet metal
  The securing consists in making the cover of soft sheet metal directly upon the top layer of the wall crest without any later addition to the existing wall. At the first stage the crest needs a suitable preparation of the surface, all the holes and caverns must be filled. The surface elements of the crest should be cylindrical in shape. The crest should not be leveled, as it would make the sheet metal fixing more difficult. A metal sheet is put on the prepared crest and then it is hammered so that it could acquire the shape retaining the pattern of the crest. Pulling the metal sheet over the front and hammering it down allows a better connection between the metal and the wall. The method is highly efficient and durable.

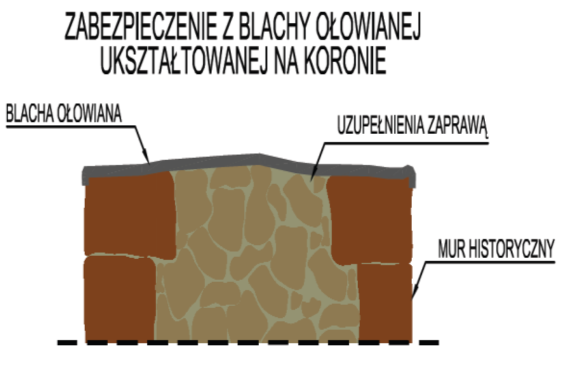

Fig. 34 Making a sweet metal cover on the Wall crest./ Securing made of lead sheet metal formed upon the crest./ Lead sheet metal/ Mortar fillings / Historic wall/

Fig. 35. The crest fragment secured with lead sheet metal. (The castle in Janowiec on the Vistula River)

- Chemical methods
  The securing devices of this type can make use of hydrophobic or sealing preparations . Along with the dynamic development of construction chemistry at the end of 20^{th} century chemical substances started to be used for surface hydrophobia of stone and brick wall crests. Their proper application requires the fulfillment of a whole range of conditions concerning the type of a preparation, the type and quality of the base (the wall material, mortar), humidity of the secured surfaces, a suitable preparation of the wall crest surface etc.

Fig. 36. Securing of the added crest with a cover (The castle in Ząbkowice Śląskie)

Fig. 37. The degraded chemical cover of the crest.(The castle in Rabsztyn)

Analysing the objects in which the wall crests were secured with the use of various types of technologies and materials one can state that the greatest influence upon the solution durability is exerted by introducing the isolation layer between the historic tissue and the material above. Introduction of the diaphragm does not influence the new securing layer – it remains exposed to degrading processes and slowly deteriorates. Isolation prevents, however, permeation of water into the lower layers, significantly restricting degradation of historic tissue. When securing the crest, both coating isolation and layer isolation may be used and their construction does not differ from the material used in cotemporary buildings. In order to make a securing one can use roofing paper, sheet steel, sheet lead, laminates, bitumic isolation coatings and plastics. An additional advantage of introducing isolation is reversible. In case when it is necessary to recreate the primary state, it will not be necessary to interfere significantly in the historic layers.

The table below provides a specification of basic advantages and disadvantages of the securing solutions used in the objects left as permanent ruin.

Type of securing	Advantages	Disadvantages
Reconstruction of a part of the wall	Durability of the securing of the historic wall Possibility of providing solutions allowing the flow of rainwater from the crest	Irreversibility Indiscernibility while using the material of a similar color and dimensions The risk of introducing cubatures incompatible with the conservator's regulations Presenting the natural processes of the origin of ruins in a false way
Addition of native material	Irreversibility of the introduced solutions Possibility of shaping the line of the crest according to the one obtained by natural factors	Indiscernibility after some time In case of lack of isolation - irreversibility of the solution Indiscernibility while using the material of a similar colour and dimension
Addition of a foreign	Discernibility of the	In case of lack of isolation -

material	introduced solutions Possibility of shaping the crest line according to the one obtained by natural factors	irreversibility of the solution
Making the crest profile of mortar or concrete	Opportunity to allow the flow of rainwater from the crest Obtaining the plasticity of the wall line compatible with the one formed in a natural way	Using cement as a component of the material has a negative effect upon the historic material
Soft capping		Necessity of making substantial additions in order to level the crest The risk of appearing of species exerting destructive, undesirable effect upon the historic wall
Roofing	Securing both the crest and the front immediately under the crest Reversibility of the solution	Low aesthetic impression of most solutions Change of the wall crest natural plasticity
Securing the crest with sheet metal	High durability of the solution Reversibility of the solution	Low aesthetic impression Necessity to determine the sweet metal effect upon the preservation of the wall material
Chemical methods	Obtaining the wall line plasticity compatible with the one formed in a natural way	Low durability of the solution Part of the substance may have a negative effect upon the historic material
Introduction of the additional isolation layers	Increasing the durability of all solutions Ensuring the reversibility of the works upon securing the crest, isolation has a role of a dividing layer	Lower aesthetic impression in case of isolation protruding from the front or using profiles removing water

4.2.4. Summary

Due to the great variety of the wall crests in state of a permanent ruin concerning their construction, material, state of preservation, height and thickness as well as the shape of the crest line it is impossible to point out one universal method of wall securing . In many cases there is a necessity of introducing various solutions within the range of one object and sometimes even one fragment of an object.

For the durability of the solution it is the key issue to introduce the isolation layer between the historic tissue and the modern supplement. The layer also ensures the reversibility of the solutions employed and in case when there is a necessity of recreation of the previous state, there will not be any serious interference with the historic layers.

The problem of a suitable way of removing water from the wall crest and its further distribution has not yet been finally resolved. It specially refers to the walls of highly irregular wall crest.

The above described ways of securing result from a compromise between the necessity of protecting the wall crests and the suitable way of their exposition that would not falsify history.

All the securing solutions require the permanent control of their state. Visual assessment supplemented with photographic and film documentation should be carried out twice a year at least, i.e. before the winter season and immediately after its end.

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5. NATIONAL REPORTS ON THE CONSERVATION OF HISTORIC RUINS

Matej Bel University (Slovakia)

STATE-OF-ART ON PROTECTION OF HISTORICAL RUINS - BIOLOGICAL RISKS

Ingrid Turisová

Institutions and communities responsible for the protection of ruins are required to diagnose and prevent the harmful effects of living organisms on the ruins. At the same time, it should be noted that they are obliged encouraging conservation of biodiversity (Drdácký et al. 2007). Conservation of biodiversity has the extraordinary importance in case, that ruins represent the suitable localities for existence of rare, vulnerable, endangered or endemic species of flora and fauna. In this case the integrated management is very important.

The physical, chemical and biological deterioration mechanisms that deal with the interaction between the Cultural Heritage and the Environment (both indoors and outdoors) are relatively well researched. In indoors of ruins, where the vegetation cover is developed (courtyards, dry moat, immediately adjacent free landscapes etc.), there are recommended the measures to prevent the spreading of weeds, allergenic, expansive and invasive species, undesirable woods that reduce not only the aesthetic aspect, but also increase the risk of public health hazard, the risk of the occurrence of fire, the loss of origin biodiversity. The most effective measures are the regular care of vegetation by mowing, removal of trees and shrubs or by grazing small herds of sheep, cows or goats in view of the risk of higher nutrient accumulation in the soil. The effective tool is also biological competition. For example, according to the newest knowledges, the native parasitic or hemiparasitic plants have the high positive effect on biodiversity of temperate grasslands (Fibich et al. 2017), as well as on suppressing competitive plants dominants (like *Calamagrostis epigejos* etc.) and vegetation restoration (Těšitel et al. 2017). This potential should be considered in restoration management of sites infested by competitive dominants, either alien or native, because it represents relatively low-cost process which is well received as by the experts as by the public. If it is possible, this approach should be in preference apply in the sites where the ruins are located in protected natural areas (national parks, protected landscape areas, also small-scale protected areas – (national) nature reserve, protected area, (national) nature monument, etc.)

Great attention is concentrated on non-vascular plants (cyanobacteria, algae and bryophytes), fungi and lichens. There are the first colonizers on the wall of ruins and the first producers of biomass. Historic stone supports large and diverse communities of these organism that colonize both the outdoor stone surface and the porous indoor. Caneva et al. (2009) published the work of dozens of scientists who have studied problems presented by the biological degradation of cultural heritage, tackling both general topics (mechanisms of biodeterioration; correlation between biodeterioration and environment; and destructive organisms) and specific ones (problems presented by different materials; various environmental and climatic conditions; and diverse geographic settings). The book also discusses solutions for the prevention and control of deterioration, including appropriate diagnostic techniques. Despite the numerous literature dealing with the damage of the materials colonized by biofilms (see reviews in Caneva et al., 2009; Scheerer et al., 2009), the relationship between mineral solubility and the role of microbial surface colonization in weathering reactions is a topic that has yet to be answered in a comprehensive manner (Davis & Luttge, 2005). Some authors stated that the lichens, mosses and ferns regulated the humidity, thermal transmission, and water vapor diffusion, reducing thermo-hygric stresses to the stone.

Several mechanical, chemical and physical techniques have been developed and applied to remove biofilms and non-vacular plants from historical monuments which are further refined.

Scientific knowledge, technological innovation and the development of new materials will provide useful tools for stakeholders to apply effective intervention strategies and plan on time proper preventive conservation measurements to increase the enhancement and enjoyment of cultural heritage (http://www.isac.cnr.it/en/research_groups/natural-environmental-and-anthropic-hazards-cultural-heritage).

STATE-OF-ART ON PROTECTION OF HISTORICAL RUINS – CARE OF THE BUILDIG MATERIAL

Peter Andráš

At first is necessary to get informations about the position of the building in the country, to know the characteristics of the background of the monument: what type of rocks/soils forms the ground under the walls, if there is no risk of landslide, if it is in the area of often earthquake, volcanic activity or floods.

Very important is to know the state of statics and about the state of roofing.

The next step is to study the building material. It is necessary to recognize its composition: types of rocks, bricks, wooden and metal structures etc. Very important is to determine the state of the building material: if and how seriously is damaged, weathered etc. To get responsible data is necessary to realize microscopic study.

For suitable recovery of the building needs one to know the source of the building material, e.g. of the bricks or rocks. In case of bricks is suitable to use bricks made from the same clay material and by same technology. In case of stone material is necessary to know the source of the rocks, if i tis from some qarry (from what quarry) or if the boulders were collected from the surroundings area, if the rocks were chisseled or not etc.

Necessary is also to get informations about the type and composition of mortar, plaster coating, external rendering, etc. and know how the interaction of mortar, plaster coating, external rendering with building material (bricks, stone, wood etc.).

It is necessary also know if the building is attacked by some chemical (acidity, carbonation, salinization, oxidation, capillary action...) or biological factors (e.g. must, moss, herbaceous or other plants, invaded by roots of trees or shrubbery).

The obtained informations enable to solve the procedure how to repair the building.

Key study (Bzovík monastery/castle).

The building complex was built in two steps: a) at first was built the Cistercian Abbey founded around 1130; b) The second structural step was the building of the fortification (Fig. 1).

Fig. 1 The Bzovík monastery (Cistercian Abbey) with the younger fortification

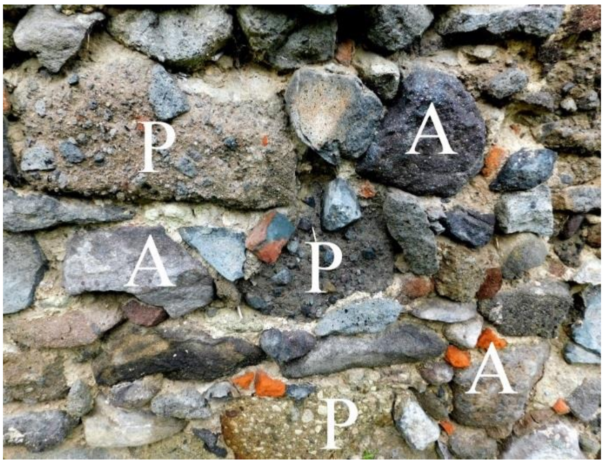

Fig. 2 Building material of the cloister (Cistercian Abbey): A – andesite, P – pyroclastic material

Fig. 3 Wall of the monastery: variegated rock material mixed with younger with bricks

The complex was built from local geological material (rocks) but there are some differencies in the rate of the used rock types during the realization of the two mentioned building periods. The predominant rock material both in the ruins of cloister, as well as in the preserved parts of the fortification consists of: andesites, dacite and pyroclastic material (Fig. 2). The cloister was built from more variegated material (Fig. 3) and in the ruins of the cloister is visible a little bit more soft rocks (sandstones, rhyolite tufs) as in the youger fortification, which is built predominantly from and andesite. Most stones are not chiselled but some little portion of the stones was carved (Fig. 4, 5).

Fig. 4 Wall of the monastery: chiselled sandstone

Fig. 5 Chapel of the monastery: carved sandstone material on the gothic window ceiling

Microscopic study of the rock material Ignimbrite - caked fragments of dacitic rocks and of fine-grained ash (parallel polars; Fig. 6). In fragments are visible zonal feldspars and pyroxens (crossed polars; Fig. 7)

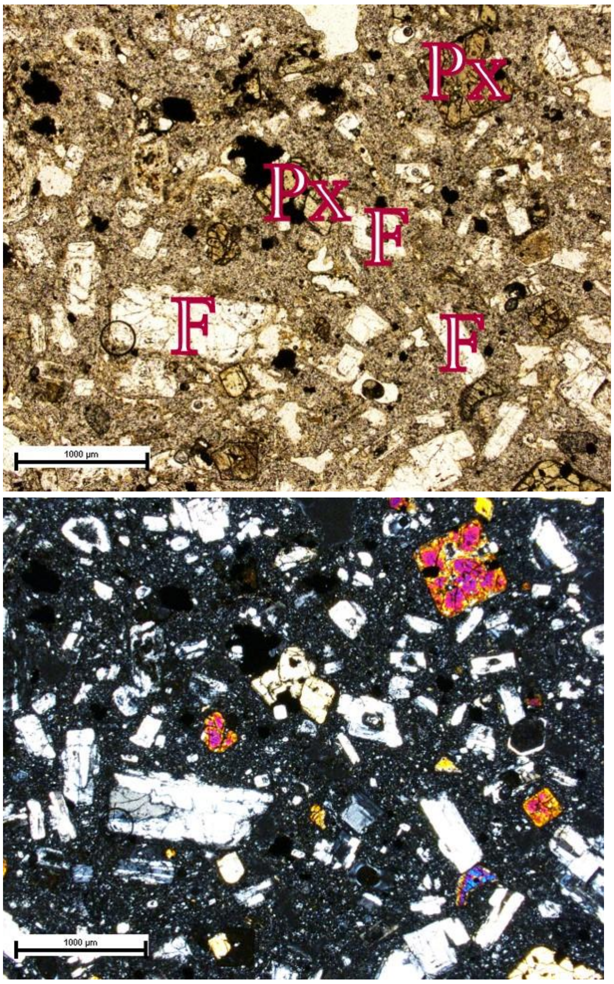

Fig. 6, 7 Detail of feldspars (F) and pyroxen (Px) phenocrysts (parallel polars and the same in crossed polars)

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Ruins in the Czech Republic

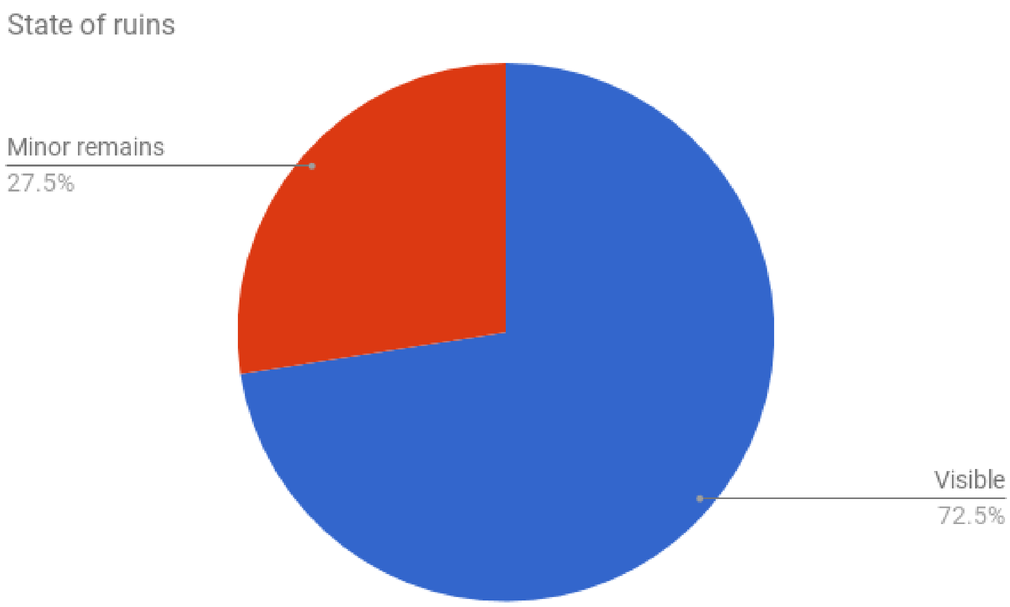
There is more than 500 historical ruins in the Czech Republic out of which approx. 270 are ruins of medieval castles and fortress. The best documented are the ruins listed on The Central List of Cultural Monuments of the Czech Republic managed by the Czech National Heritage[3]. There are more than 89 000 cultural monuments officially recorded there. In these recorded monuments, approximately 40 000 objects are protected as immovable cultural monuments and there is the same number of protected movable cultural monuments. More than 300 recorded cultural monuments are protected as national cultural monuments. There is 480

[3] See http://pamatkovykatalog.cz/

objects stated as a ruin from of which 241 are castles or fortresses. Except for a few exceptions, all listed ruins are somehow protected by the law[4].

There are some other database of ruins provided by individuals[5] or private tourism companies.[6]

Most of registered ruins is well visible in the field, about one quarter has only minor remains.



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[4] The basic legal in field of culture heritage regulation in the Czech Republic is the Act on State Monument Preservation (Zákon o státní památkové péči) No. 20/1987 Coll., as amended, including decree of the Ministry of Culture (vyhláška ministerstva kultury) No. 66/1988 Coll., implementing the act of the Czech National Council No. 20/1987 Coll., on State Monument Preservation. The monument preservation act has been subject to many amendments.

The requirements and content of the plan for the protection of heritage reservations and heritage zones are regulated by decree of the Ministry of Culture of the Czech Republic (vyhláška ministerstva kultury) No. 420/2008 Coll.

Degrees of protection:

- National Cultural Monuments – the most important cultural items (e.g. ruins of the Hussite's Castle Kozí Hrádek, ruins of the medieval castles Bezděz, Kunětická Hora, Lipnice nad Sázavou, Přimda, Rabí, Trosky, Velhartice)
- Cultural Monuments – listed monuments listed in the Central Register of Cultural Monuments (the vast majority of ruined castles and churches)
- The location on the territory of specific heritage protection

See e.g.: http://www.hrady-zriceniny.cz/hrady.htm
http://www.castles.cz/search.php

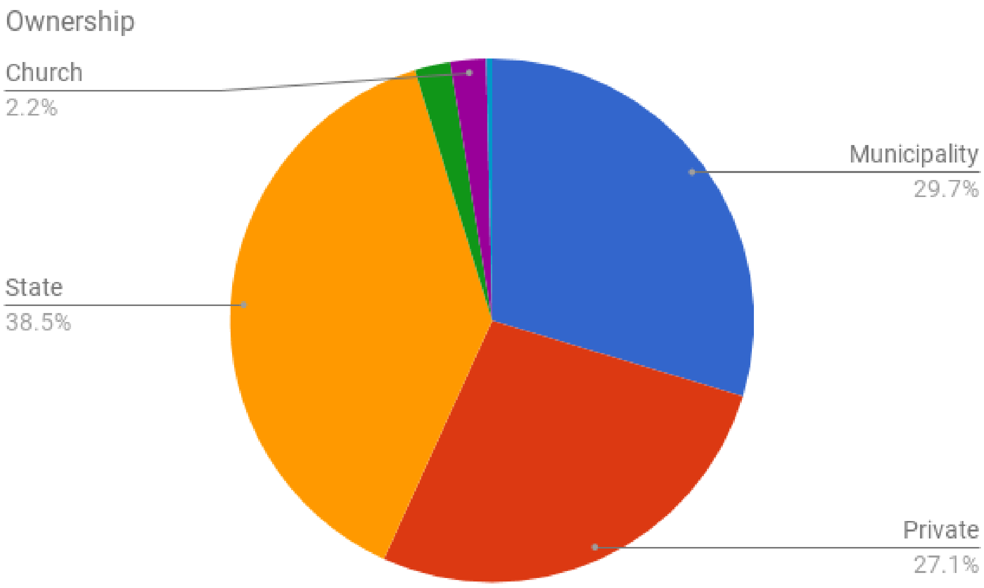
See e.g.: http://www.atlasceska.cz/ceska-republika/hrady-a-zamky/zriceniny-137/
http://www.zriceniny.eu/
http://www.hrady.cz

Ruin of castle **Trosky** is an example of ruin well visible in the field (and also as dominant in the countryside):

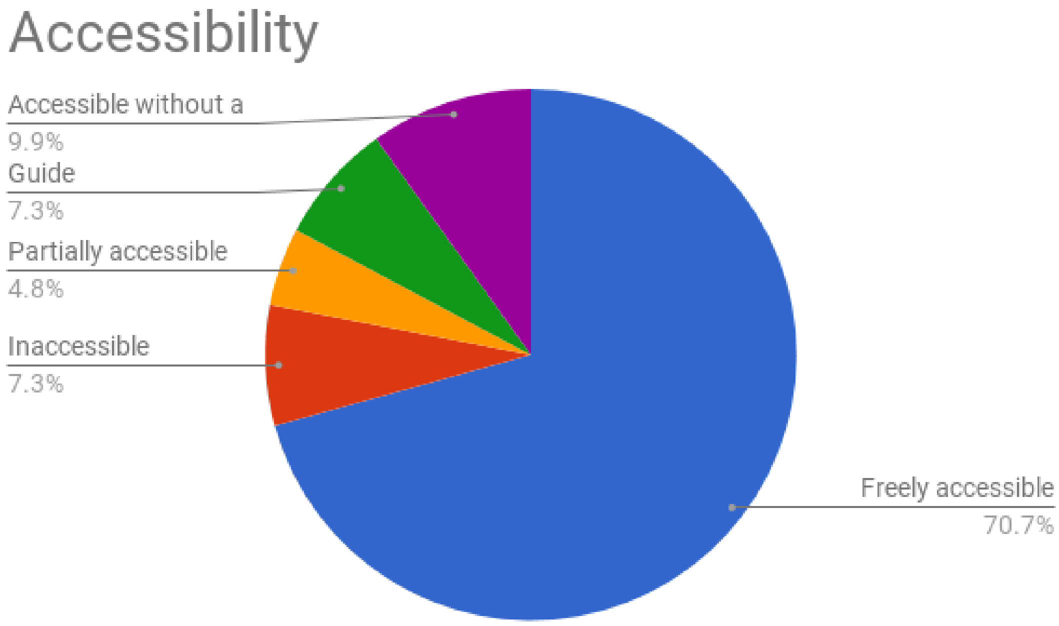
Ruin of castle Lopata is an example of touristically accessible ruin with minor remains[7]:

[7] Source of the picture: https://commons.wikimedia.org/wiki/File:Lopata_castle_1.jpg

In terms of ownership, most of the ruins in the Czech Republic are owned by the state. Directly owned by the state is 38.5% of ruins. There is 27,1% of ruins registered as owned by private subjects, but one of the largest owners is the state enterprise *Forests of the Czech Republic*. So there is about half the ruins in the state ownership. Municipalities are another significant owner of the ruins in the Czech Republic – nearly 30%. The churches then own less than 3 percent of ruins and regions (higher territorial units) around two percent.



There is only 7,3% of ruins inaccessible in the Czech Republic. The remaining objects are in some way accessible: 70,7% totally freely accessible, 9,9% charged access without guide, 7,3% charged access without guide and 4,8% partly accessible (free access but only to part of object).



Comments to current state-of-art on protection, conservation and preservation of medieval ruins - Czech Republic

According to literature the term torso means an incompletely preserved or incomplete thing, sometimes inaccurately incomplete. Torsional architecture arises as a result of the loss of the original purpose of the building. These objects were left to long-term deteoriation and there was no reason to rebuild or remove them. In cities these buildings are therefore quite exceptional, because there is an effort to maximize the use of space. In cities there is deliberate devastation of buildings by the inappropriate individuals or poor maintenance in order to destroy the building and release the land for new construction. This is one of the negative phenomena.

Czech preservationist Ondřej Šefců[8] states that torsional construction in the classical sense, these are remnants of historical buildings. These buildings lack basic functional elements such as roof, gutters, windows, doors and so on. Determination torso construction, however, is not clear. Monument care must therefore be accessed separately to individual buildings.

Most buildings have a number of common denominators:

[8] Ševců. O. Problémy při opravách torzálních památek. Poznatky památkáře. Sborník přednášek z odborného semináře STOP, STOP 2017 (in Czech)

1. Do we have a targeted rescue and torsion presentation? In many cases, it is best to leave the building and found in their natural form and not to interfere with processes of aging.

2. If the torso is to be presented to the public, the question is to what extent, as all the interventions on the one hand preserve the construction, on the other, the building loses its own self-sufficiency.

3. It is therefore necessary to determine the form of torsion to be used. This problem involves control and maintenance associated with a higher degree of use of the building. Things without intervention are subject to aging very quickly, exponentially.

Technical problems to be solved while maintaining the buildings: protection against climatic and biological influences and, last but not least, before the people themselves.

On the basis of practical experience, some applications can be designed to preserve buildings:

1. Trees are rather positive and lead to the preservation of the picturesqueness of the building

4. Planetary greenery must be removed, especially if it interferes with its root system into the masonry. However, this must be done with caution, as roots can support the construction

5. Prevent excessive moisture in the building (drainage, runoff, temporary or permanent roofing)

6. The support of internal masonry, which has not been built on external stress, may also be necessary

7. In order to make the building accessible, it is necessary to set up paths or embedded structures. Social background is also essential. These structures, however, should minimize the impact on the historic value as well as possible to fit in context

It is not the ideal solution, it is always a compromise. This compromise of exploitation and maintenance of the building's independence should therefore be thoroughly investigated by the professional public.

Ruins are a valuable source of authentic scientific information and have a specific emotional basis. In 2nd half of the 18th century in English came an interest (proto-Romanticism), which began to repair and maintain the ruins intentionally. In the period of purism (2nd half of the 19th century), there was a strong tendency to complete the ruins in to its “original” form. The predominant conservation attitude to the ruins in the Czech Republic still now days is influenced by Jan Sokol's methodology. The main features of thus methodology are following. [9]

Heritage conservation represent complex problem. We must respect and protect the value of ruins as a full-fledged historical source capable of wide-ranging testimony. Therefore, there are no general rules and each case requires a distinct approach. However, there are general principles and recommendations that have emerged from practice.

Sorting an object

In most cases are the ruins the result of gradual dilapidation (but it can also arise as a result of a disaster). The dilapidated building goes through several phases:

- The building has lost its wooden parts (timber roof truss, ceiling, timber framing walls), only brick skeletons remain and the building is open to weathering.
- The vaults crashed and the walls cracked, water leaked the walls, and there was a rupture in some places. The openings in the walls grew and the weaker part of the wall fell.
- The masonry is still a whole, but contact with the original terrain level and the relief is lost.
- There were discontinuous ruins in a heap of rubble, vertical cliffs were created.
- All the walls crashed, the castle turned into a construction waste covered with lush vegetation.

Each phase requires special kind of construction work.

Architectural style or ruin

It is necessary to estimate the style of the ruins and to adjust the building and other interventions accordingly.

Heritage value

[9] See: Sokol, J. - Dudík, T. - Štulc, J. Ochrana, údržba a stavební úpravy zřícenin hradů. Státní ústav památkové péče v Praze, 1998 (in Czech)

Art-historical analysis of the building has the main importance in assessing the value. Building-historical analysis, archaeological research and archival searches are also important. We need a plan of ruin to analyse the value, it is important to be detailed and reliable, because documentation becomes a historical source. The results of a high-quality and comprehensive survey serve as one of the most important documents for defining the practices and ideological concepts.

Social function of ruins

The social use of the building must not be forgotten. The most appropriate use of ruins are as a tourist destination. The interventions that destroy the authenticity and historical value are the most dangerous. Any proposal must show that it is compatible with the building's historical value, that it is feasible and that the consequences of the intervention are not disposing. Adjustments must not destroy or alter relief around the castle.

Concept of repair work

The concept of monument repair serves as a basis for investment and designer work. The complexity of the concept grows with the complexity of individual parts of the whole. It is necessary to consider whether the repairs under consideration are not so much contrary to the maintenance of the building's historical authenticity. Authenticity should be on the first place. The main principles in the reconstruction of the monuments are:

Preservation - This term includes maintaining the current state, providing construction and eliminating the causes of accelerating destruction. The main factor is water. The building should always be as secure as possible against it. Other building modifications ensure, in the first place, wall stability. During repairs, however, must be maintained all the characteristic elements of the building (joints, walled or torsionally preserved holes, chimney and toilet shafts and so on). The principle of all preservation is to be as little visible as possible. Repair of the ruins by conservation method is the most frequent and methodologically the most correct solution in conservation practice. Conservation methods preserve the most authenticity. However, any interventions in relief modifications are not allowed without the participation of an archaeologist. Regular archaeological research is a necessity, ideally it should be the first step, even before the conceptual reflection. After documenting the archaeological state, however, it is necessary to return everything to the original state and to obscure the findings again. Returning to the original state is a necessity, as otherwise all discovered findings are damaged.

Reconstruction - Sometimes we can´t only maintenance and we have to go through the reconstruction. The reasons for this may be technical (sometimes it is necessary to fix the masonry before destabilization or build a shelter to protect the findings), utility, or ideological.

We have these options during the reconstructions: I. partial reconstruction - It is always an effort to differentiate new parts from the parts of the original ones (For example, different processing of the surface of the stone during chiseling.). The most tricky task is the roof. Thanks to the roof, a totaly new building is being built. This should be avoided whenever possible. If not, we only solve the roof as a means of purpose and try to make it inconspicuous. II. total reconstruction - It should occur only in exceptional cases, as it contradicts the current concept of preserving the authenticity of historic buildings. III. reconstruction in hint - Considered the best repair option. This is an overall restoration of the historical appearance with elements that only indicate the parts that have disappeared.

In all cases it is essential to avoid the completion and formation of neoplasms.

Implementation of building repairs

Repairs are often different from those commonly used today. It is mainly about the application of traditional historical processes, but which now controls fewer and fewer experts.

The most common work that occurs when preserving and repairing ruins:

Vegetation – Vegetation has its positives and negatives and it is necessary to decide what prevails. On the one hand, the vegetation forms a cover, windbreaks, aesthetic aspect. On the other hand, however, the structure may damage the root system.

Treatment horizontal surfaces - These parts suffer the most and the degradation of the building begins. The problem is penetrating water, which must be minimalized. A good solution is the use of grass turf or drought-resistant plants, such as the cover, or creating of water gradient and repairing of the upper parts of the masonry.

Adjustment of vertical surfaces - Water is also a problem here. The problem is falling out of stones from walls, which is caused by the soaking water. It is important to restore the interconnection of walls within the whole and to prevent the masonry failure at the heel of the building. Joints must also be handled inconspicuously or, if necessary, plastered with lime mortar. It is also essential to preserve historic plasters.

Treatment of fracture surfaces of walls - It is necessary to supplement lost masonry material with identical and fix it with mortar. The overall impression should not be contrived.

Used material - It is best use in place lying material or similar. Use a mortar from well matured lime as a binder. It is particularly unsuitable to use concrete. Cement plasters damage masonry as they are impermeable for water. Cement can be used only inside the masonry.

Ruins mode

The basis for maintaining the functionality of the buildings even after repairs is the regular check of the vegetation cover and attendance. It can be very beneficial to breed herds of sheep that are able to control vegetation. Control of the human factor should consist of guiding hiking trails, avoiding excavations for the seeker, or organizing sporting events.

City of Zadar, Zadar County Development Agency ZADRA NOVA (Croatia)

Report on the current state-of-art on protection, conservation and preservation of medieval ruins

The notion of Heritage in Croatia

The common division of movable, immovable and immaterial heritage is applicable in Croatia as well. It is an important dimension and legal status, whether the historical ruin is a registered heritage or an material good that has not yet been legally determined or institutionally treated. The legal status as a proper definition criterion can be applied regardless the property, which can be private or public.

In European frameworks, investing in sustainable protection and conservation of cultural heritage is no different from any other investment process, but given the particular valorization in the form of cultural preservation identity, financing cultural heritage is not just a cost. The cultural heritage is a resource that requires preservation, care, valuation and use according to the principle of sustainability.

The Ministry of Culture of the Republic of Croatia is responsible for preservation of cultural heritage as un important entity and they are the responsible ones for determination of frameworks for its sustainable use. It is a key role of the cultural heritage protection services, along with efficiency and accessibility both individually and institutionally, ability to adapt to new funding opportunities, engagement in to establish and apply transparent standards and to be successful in preparing and running projects for international and domestic sources of funding.

An important element for the protection, preservation and use of cultural heritage is an effective system of registrations of cultural heritage goods. The registration system should have a complete, comprehensive, transparent, available to the experts, public and investors register of cultural goods. Information system should ensure fast, efficient and quality planning and prioritizing of financing for the protection and conservation while determining the conditions, purpose and use of each and every category of cultural heritage.

Protective construction works on immovable cultural goods including the medieval ruins.

- The state proposes to co-finance the restoration and conservation actions on historical ruins.

The application (proposal of reconstruction program) for co-financing of protective works on a historical property can be submitted for individually protected immovable cultural property and for immovable property within the protected cultural-historical site or protected landscape enrolled in the Register of Cultural Goods of the Republic of Croatia.

In addition to all applications for cultural heritage protection and conservation programs, documentation must notify the organization with the budget line of restoration activities (attached to the application form).

The state procures the services if the cultural good in question does not have the required project documentation or conservation documentation, the Public Program in that case assists in production of necessary documentation.

Due to the duration of the program, a one-year or three-year program, the project for the protection and preservation of immovable cultural goods can be applied, and all interested partners, regardless of status, are obliged to submit a strategic plan for the entire duration of the proposed program.

- **Things to improve**

The richness, the diversity and variety of cultural heritage and its general condition require further financing from international and private sources as well as the use of legal opportunities to ensure intellectual property and penalties for damaging the cultural heritage.

Apart from finding other financial resources and taking measures to diversify knowledge and skills, more interest and commitment are needed from key stakeholders and all interested parties for sustainable protection, conservation and preservation of cultural heritage. They all need to unite through mutual definition of goals, measures and projects for better preservation of Heritage and the implementation of the same.

The strategy of protection and preservation which is a commonly planned program / tool, is aiming towards more effective and successful management of the protection and preservation of cultural heritage, and at the same time it encourages and strengthens the economic use of development potentials and heritage. The strategy is made in accordance with the procedure and standards applicable in the European Union.

The objectives of the Strategy are as follows:

• Establish a comprehensive basis for the use of cultural heritage as a development resource in accordance with guidelines for cultural development and protection of cultural heritage, regional development and economic development according to EU standards and other international institutions.

• Ensure a reliable institutional and foundation program that guarantees the necessary conditions for identifying, preparing and running the projects for the state protection programs with the institutions of the Republic of Croatia, the EU founds program and other international institutions foundations programs.

• Develop and strengthen the skills and abilities of experts in the Ministry of Culture and others state administration bodies and organizations, especially the experts and developers in local units and regional self-governments, in order to achieve successful preparation and management of projects for sustainable protection, conservation and preservation of cultural heritage.

• Strengthen partnership (public participation) and inform professional and wider public about the importance of cultural heritage as an important resource with many opportunities for its economic use in accordance with the principles and practice of sustainable development.

The problematic regarding the state of art of protection, conservation and preservation of medieval ruins.

The architectural cultural heritage is exposed to rising influences and pressures of modernization which makes its material structure particularly sensitive and prone to decay. The recent conclusion is that the degradation of part of the architectural heritage has reached such proportions that it considers many cultural and historical ensembles, as well as the individual cultural goods.

A part modernization and increased urbanization some other external events contributed to the degradation of historical sites: war destruction, lack of attention and lack of support, insufficient financial resources, unresolved property and legal relations, non-compliance with legal regulations and non-observance of sanction, insufficient awareness of the value of the heritage. Particularly difficult condition of architectural heritage is in villages and country sites and small historic towns where historical buildings are without purpose or use.

Architectural cultural heritage is also jeopardized by inappropriate construction work, which does not applie the appropriate conservation conditions and is often performed without expertly verified conservation and technical documentation.

In particular, the mediaeval old architectural complexes (prisons, castles) are threatened, mostly due to their position, harder accessibility and poor documentation. It is important, therefore, to pay special attention the medieval architectural heritage outside the inhabited areas and design for them appropriate programs and content. The Ruin of st. Stošija in Zadar that was in use as an early medieval church is not in use for a long time and it is threatened by the rapidly increased urbanization of the very touristic sector where it is located.

Usually the Sacral buildings and complexes mostly continue to have a purpose, so the investment in their maintenance is continually. Difficulties arise in the economic valorization as the owner is unwilling to open sacral goods to the public so, except the Parish churches in function (in which the liturgical rituals takes place) are in a better state, while the churches and chapels that are out of function are in worse shape.

Good results in the protection and preservation of architectural heritage have been achieved where there were important researches and direct interventions on buildings made by finding the most suitable solutions for protection and conservation by involving a wider number of professionals from the local community and civil society. Successful Conservation and protection is a good indicator of raising awareness about the importance of Protection and preservation of archaeological heritage and it is mostly carried out by the Department for the Protection of the Cultural Heritage.

Archeological research and protection

Archaeological research in Croatia is organized within ten institutions with exclusively archaeological profile, whose main activity is scientific and study work (six archaeological museums, one institute, two departments at faculties in Zagreb and Zadar and one department in the Croatian Academy and science and art). Some archeologists are also employed in museum facilities that belong to the general type of museums according to the type of museum. There are also several private archeological companies, which are technically and personally equipped for archaeological research, and their work is mainly focused on archaeological protection excavations.

Restoration activities as well as archaeological research itself are carried out within the public domain Institutes The Croatian Restoration Institute (HRZ), which has its own Department of archeological heritage separated in three departments (Department of Land Archeology, Department of Underwater Archeology and the Department of Restoration of Land Archaeological Findings).

Restoration activities also take place within certain museums that are equipped with restoration workshops and there are some private restoration offices that are in function with professional team.

Things to improve

Although planning and systematic staff training for archaeological heritage conservation and conservation does not exists, and the conservation and restoration apprenticeship is only partially covered by programs of higher education, given the long experience of institutions in performing these jobs the state of art situation can be assessed as acceptable. Current state of professional teamwork and competencies for archaeological research can also be considered acceptable.

Information and Communication Technology (ICT) in Protection Institutions and conservation of cultural goods is not at a satisfactory level. Especially, the equipment for diagnosis of physical condition is lacking and it determines the causes of decay of archeological goods. ICT equipment institutions and companies involved in site research are at a satisfactory level.

Considering effectiveness of protection and conservation some qualitative leaps are still unsatisfactory because the institutions did not yet make the connection between the protection and economic use of heritage. These two sectors move in separate and often opposite directions which has to be changed.

Systematic care for the protection, preservation and presentation of immovable archeological heritage must create the conditions for the economic use of these goods, but the internal organization and profile of employees have to be maintained at certain level.

The institutions that take care and manage the immobile archeological heritage (ex. museum) as non-profit organizations, suffer from the lack of clarity and competence (legal regulation, management and organizations, human resources, infrastructure) for create an alternative form of archeological use and preservation.

Some archaeological sites that are in the larger or smaller way presented and accessible to the public usually rarely offer more than a guided visit. Although the number of events related to individual archaeological sites has increased, those are mostly one-time (annual) events, not intended to permanently increases attractiveness of archeological good.

SiTI – Higher Institute on Territorial Systems for Innovation (Italy)

Report on the current state-of-art on protection, conservation and preservation of medieval ruins

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The conservation of ruined heritage: historical excursus

The general aspects of heritage conservation, including legislative ones, were considered for the first time internationally during a conference held in Athens in 1931. The ethical guidelines to be adopted in the case of works carried out on monuments and on protected archaeological sites; all these recommendations are also known as the Athens Charter. This remains an important reference as it marks the beginning of a long series of documents that indicate standards of practices recognized at an international level, anticipating those principles that will be enshrined later by specific international conventions. These recommendations, based on the recognition of the heritage to all humanity and on the need for cooperation between states, concern aspects of conservation such as maintenance, continuity of use, legislation, documentation, awareness raising . As far as the restoration is concerned, indications are given on consolidation, on the use of modern materials, on respect for the stylistic unity and the context. The references to the archaeological heritage concerning the anastylosis, the covering with earth as a measure to preserve the "ruins", the close collaboration between archaeologists and architects are limited. The UNESCO, created in 1945, approved, starting from the fifties, a series of conventions concerning the protection of cultural heritage, including archaeological sites, collections of movable property, landscapes and immovable assets. In 1954, on the initiative of this organism, the The Hague Convention was approved on the protection of cultural heritage in the event of armed conflict, which was followed, two years later, by specific recommendations regarding archaeological excavations (International Principles Applicable to Archaeological Excavations). The principles set out in this document, approved during the UNESCO General Congress held in New Delhi in 1956, can still be considered valid, as they affirm the responsibility of the institutions to protect and promote the knowledge of the archaeological heritage in their own territory and the relevance, in collaboration with other organizations, through research, documentation, maintenance, restoration. The educational function of heritage is underlined by the need to make archaeological sites accessible and "readable" to visitors, with the result of increasing public awareness of that heritage. In situ conservation is proposed as a possible solution for monuments, while the use of leaving "witnesses" in the archaeological areas investigated is encouraged in view of future research, supported by more advanced knowledge.

The Council of Europe, a body founded in Strasbourg in 1949, issued papers, recommendations and guidelines in the field of heritage conservation, considering more the social aspects and changes in the values of society. The text that most influenced international conservation approaches was probably the Venice Charter (1964), the result of the II International Congress of Architects and Technicians of

Historic Monuments. From this derives the Italian Restoration Chart (1972). In actual fact, this document dedicates only one paragraph to the conservation of archaeological sites (Article 15): based on the principles of the archaeological investigation expressed in the 1956 Convention, maintenance, presentation, anastylosis and integration are contemplated. Already in the Athens Charter the anastylosis, intended as a reassembly of original elements found in situ, was considered desirable; now it is referred to as the only form of reconstruction admissible in the archaeological field, provided that the new materials used for possible additions are distinguishable from the ancient ones. More recently, the role of reconstruction in experimental research and in the interpretation of archaeological evidence has been underlined, according to the criterion of authenticity (ICAHM Charter, Article 7). The recommendations presented in the Venice Charter led directly to the creation of ICOMOS (International Council on Monuments and Sites, Warsaw 1965). In the thirty years since its foundation, the international scientific committees and the national committees of the ICOMOS have developed the basic principles of the Venice Charter, giving more importance to the practical implications concerning the ethics of conservation.

In the following years, a UNESCO convention dealt directly with the problem of illegal circulation of cultural heritage (Means of Prohibiting Illicit Import, 1970), which then encountered enormous difficulties in being adopted by several countries, especially from those who were the recipients of clandestine traffic. Two years later it was the protection of cultural heritage on a world scale, in the broadest sense of the term and including environmental goods, the theme of the World Heritage Convention (1972). This convention for the protection of the world cultural and natural heritage clearly affirms the universal nature of these resources and the collective responsibility at international level for guaranteeing their protection. The definition of a world cultural asset is based on the recognition of an exceptional value from different points of view: historical, artistic, anthropological, for example, for cultural heritage; aesthetic, scientific, conservative for the natural one. International protection is intended to support the identification and conservation of this heritage through a system of cooperation and assistance.

ICOMOS also approved a specific text on the protection and management of the archaeological heritage (Charter for the Protection and Management of the Archaeological Heritage, 1990), elaborated by the ICAHM, one of the commissions operating within the ICOMOS. It builds on UNESCO's conventions and recommendations on archaeological heritage, confirming the substantial validity of existing rules. It is linked in particular to the 1956 recommendations on excavations, to the 1954 and 1972 conventions for the definition of the patrimony of humanity. Considering the precedents, the ICAHM Charter was born from the need to collect the principles related to the management of the archaeological heritage in a single, internationally valid text. The term management (management), used in this case for the first time, indicates the set of operations that have as their objective the knowledge, protection, conservation and presentation to the public of archaeological resources. The ICAHM Charter constitutes a reference text both for institutional procedures and for the activity of professionals and scholars. The archaeological heritage, which also includes the underwater one, is defined as a fragile and non-renewable resource; the main risks of destruction are identified in land development and exploitation projects, which often do not take into account the presence of archaeological remains. This widespread threat, which characterizes the current situation on an international level, makes it even more necessary to resort to legislative instruments suitable for protection and, at the same time, to a territorial planning that guarantees planned interventions also for the archaeological heritage. In this sense, heritage protection should be an integral part of planning and territorial planning. The involvement of the public is presented as a determining factor in the realization of integrated conservation in the territory, in particular where aboriginal populations are present. The indigenous groups must therefore be guaranteed an adequate level of knowledge of archaeological resources, in order to be able to intervene in decisions on the protection of heritage.

The Malta Convention on the Protection of the Archaeological Heritage, voted by the Council of Europe in 1992, is part of the European context. The document, which reflects the general guidelines expressed in the ICAHM Charter of 1990, reiterates, among other things, the need for a complete knowledge of resources through inventory and classification of assets, as well as the importance of operating in a mood of interdisciplinary collaboration, exchanging skills and experience, and promoting the training of qualified professionals in the field of conservation. A particular mention deserves the art. 9 on public awareness: the commitment to communicate with visitors, informing them, is aimed at their involvement in the protection of heritage. In general, the idea of empowering the public on the problems of conservation expresses a cultural climate in which public enjoyment is one of the main objectives of the research and safeguarding activity, as also indicated by the importance that is attributed to archaeological work, to the presentation of the site, accessibility and dissemination of information.

Picture 1: Mileto Medieval Archeological Park (Italy)

Main current orientations for the conservation of ruined sites

In the conservation of historic ruined buildings, antiquity does not represent a discriminating factor in the application of archaeological discipline. According to Luigi Marino, one of the most influential Italian scholars in the sector, "archaeological buildings in good condition can have usual treatments in the architectural restoration, while buildings less ancient, but reduced to the state of ruins, require a methodological approach and different interventions" . Archaeological restoration is a specialized area of the widest discipline of restoration because, for some specific interventions, specific multidisciplinary skills are required, among which, firstly, archaeologists and architects. The current overview sees the establishment of a restoration methodology based on the minimum intervention and on the systematic maintenance of the artefacts, with particular emphasis on the diagnostic investigations in order to more attentively evaluate the degenerative phenomena.

The fundamental objective of the conservation of the archaeological heritage is, as already mentioned, conservation in situ. This entails the need to eliminate risks, ensure the conservation and maintenance of the selected sites and plan the presentation to visitors. Considering the potential historical importance of all the elements, any intervention undertaken involving choices or risks of elimination of the historical layers must be based on a clear intervention methodology and demonstrate to be well integrated in the general protection policy, respecting the assumption of the meaning and character. It is also essential to include architectural works and objects found in the context of urban land planning, in a protection and restoration program, in order to reduce the level of risk and ensure the utmost care to all significant elements. The knowledge and enhancement of an archaeological site includes the restoration of structures and elements in situ, their indication with appropriate signs and their presentation through guided tours and itineraries of various interest, with guides and direct publications to various types of public. Furthermore, the restoration helps to read and interpret the historical and artistic significance of the monument. Considering the fragility of the archaeological heritage, it is often necessary to implement protective measures against the elements by means of coverings or other means. These structures must be designed in relation to the historical and aesthetic integrity of the site and in such a way as to hinder its vision as little as possible. Similar precautions will also be required to avoid damage to the archaeological layers in the subsoil, for example by performing geophysical or excavation inspections before constructing or building shallow foundations.

Current operational steps for the conservation and protection of the ruins

THE DIAGNOSTICS

Today the restoration presents a scan of interests and operational opportunities that cover a broad range of skills. Among these particular importance assume the diagnostic aspects. It is common practice, in the most advanced restorations, the definition of a correct investigation of the recent and remote anamnesis, the history of the "diseases" and therefore of the interventions that an artifact has found itself to undergo; the current state, sometimes unclear, can be understood in the light of the analysis of what happened in previous times, with researches capable of bringing out conditions that could not be suspected of summary observations. The evidence of the state of affairs should be recorded directly on thematic maps that can be superimposed on reliable (dimensional and material) reliefs or on specific cards, highlighting identifiable general pathologies and those that, under particular conditions, manifest themselves in an anomalous manner and are not perfectly recognizable.

The investigations (preliminary and those gradually added as a consequence of subsequent emergencies), if correctly performed, may constitute a sort of 'clinical record', in a temporal sequence, of great utility for the assessment of the course of the phenomena of degradation and failure; a framework to which to constantly refer for the definition of subsequent interventions, avoiding exaggeration of investigations but above all avoiding to neglect or underestimate aspects that, in more advanced phases of the research, may prove more important than it was, at first, foreseeable.

The investigations must be able to define, with the maximum possible accuracy, the level of danger in which the products are placed and the relative risk threshold, with the assessment of the speed of deterioration, with a view to defining a correct intervention therapy. Prevention in restoration is important, how little practiced.

Every operation of conservative restoration, however urgent, should be based on a rigorous investigation of the degradation factors to which the artefact is exposed and which have caused the apparent damage and will cause further damage if they remain unaltered. The need for a real diagnostic campaign is therefore identified as the first act of knowledge and planning of conservation action.

In the field of conservation, as in medicine, diagnosis means determining the nature or location of the disease based on the evaluation of symptoms. Diagnostic techniques, applied to cultural heritage developed from the 80's, are now disseminated at all levels of the construction process for the assessment and decay measurement symptoms.

To completely describe a historic building state of art, it is essential to know the sequence of actions that led to the current configuration. To define a comprehensive diagnostic framework is essential to integrate and understand the historical and instrumental data.

Among the main tools and techniques commonly used in diagnostics for cultural heritage, we can mention:

IR THERMOGRAPHY

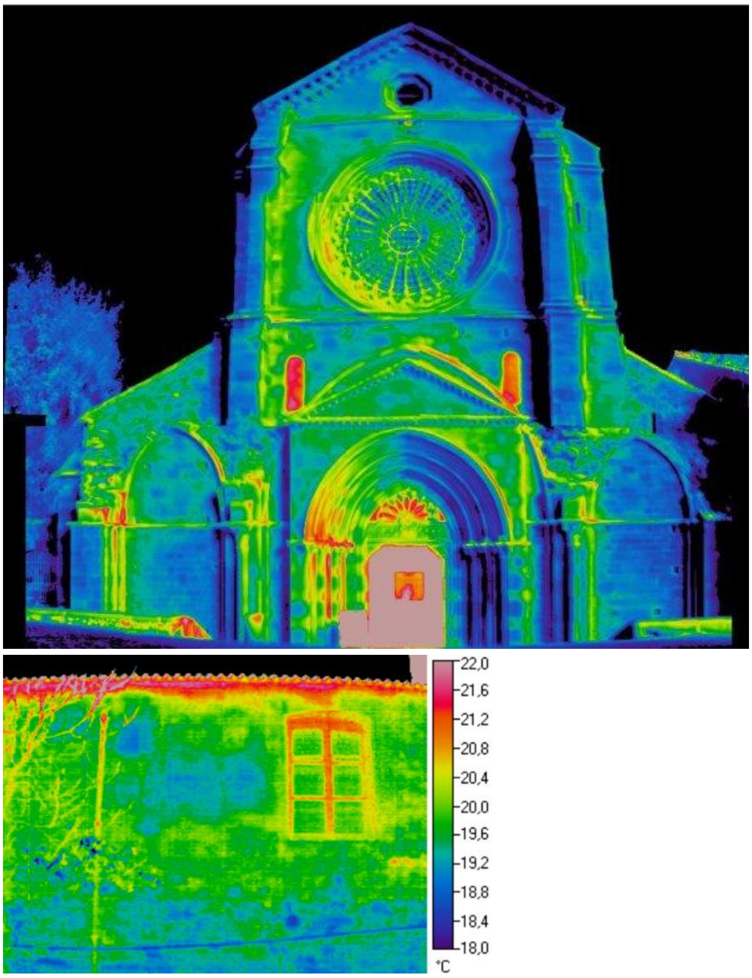
It is an absolutely non-destructive diagnostic technique that, by measuring the infrared radiation emitted by a body, is able to determine its surface temperature.

Maps are generated, in false colours, representative of the areas investigated. These maps associate a corresponding colour with a measured temperature. The sensitivity of the equipment can even reach a few hundredths of a degree.

The mapping of the surface temperature is fundamental in order to evaluate the state of conservation of the materials themselves. Materials at different temperatures are symptomatic of degradation pathologies in progress on the building or on the analysed technological system.

The thermographic allows to know the materials that make up the surface layers of a wall section and to check the presence of moisture inside it

It is based on the radiant emissivity of the materials: a material, subjected to exposure to a heat source, emits thermal radiations according to its chemical-physical characteristics



Picture 2: Examples of termography outputs

ENDOSCOPY AND VIDEOENDOSCOPY

Endoscopic investigations are used for the on-site examination of both natural and artificial cavities in order to directly observe in inaccessible points morphology, typology and state of superficial conservation of materials, floors and all those structures or materials that can be easily investigated through small diameter holes.

Picture 3: Endoscopy

SONIC AND ULTRASONIC TESTS

The sonic tests allow to perceive the (empty) discontinuities within the materials through the percussion and the propagation of sonic waves. These tests require that the restorer architect be able to understand the conditions of the masonry or of the wooden elements subjected to percussion according to the quality of the sound response.

A more in-depth investigation is represented by the ultrasonic tests which are based on the speed with which the waves pass through a solid. This type of survey is particularly suitable for checking the presence of discontinuity in the wall section as the speed with which the waves cross a solid varies according to the characteristics of the solid itself

GEOELECTRIC PROSPECTING

A non-destructive test based on a transmitter, a signal receiver and a computer is that of geological prospecting.

Used up to a few years ago only to investigate the land, today, the geological prospecting allows to read the discontinuity between materials based on variations in electrical conduction capacity.

Picture 4: geoelectric prospecting

MAGNETOMETRY

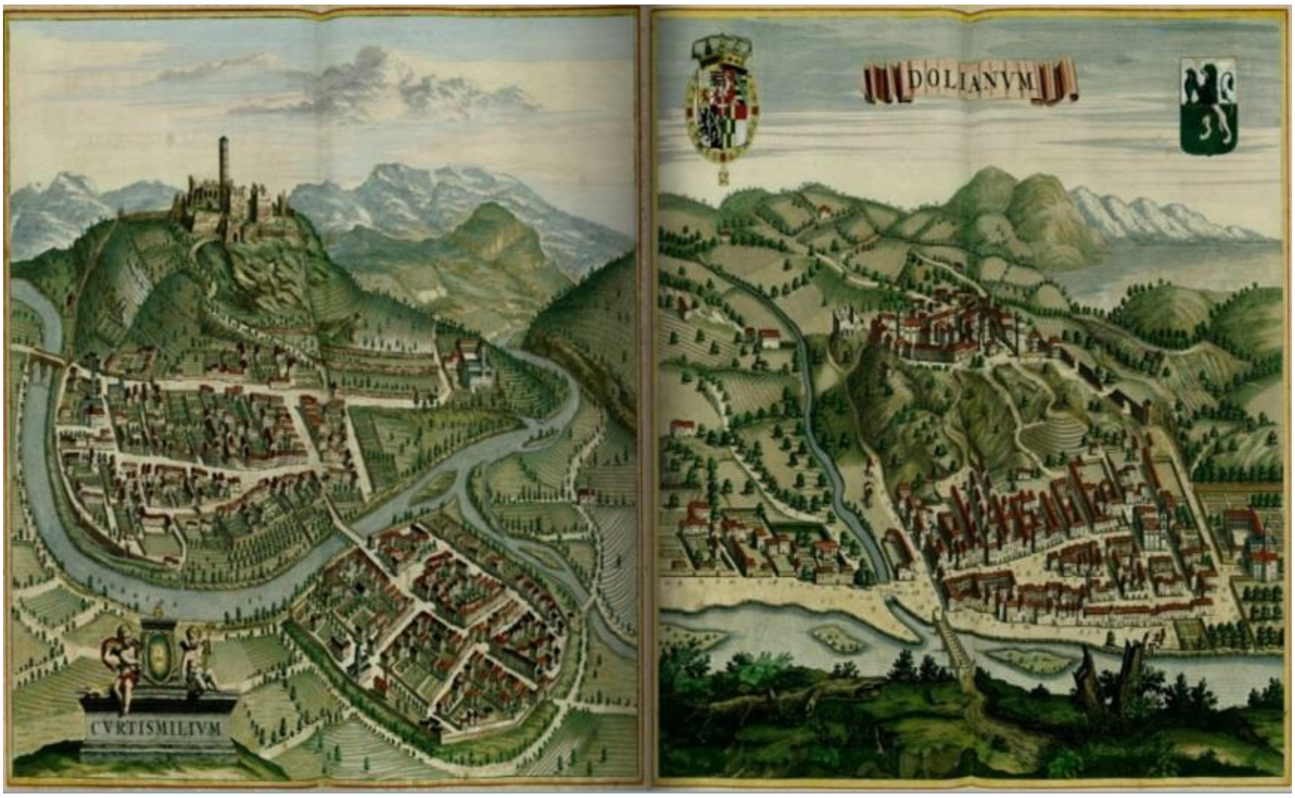
The type of non-destructive survey is magnetometry, which, through the use of a pachometer, allows the detection of the presence of metals inside the walls.

The usefulness of this investigation is evident when there are oxidized metal elements, reinforcing bars, but also grates or locks of buffered fixtures, or old plant piping, generating lesions in the otherwise unexplained masonry in the general cracking framework of the building.

ESTIMATED EXAMINATIONS AND DATA COLLECTION

Relief and documentation

To set up and program the intervention methodology, it is essential to have a comprehensive graphic, photographic and archival documentation. On the graphical surveys (in plan and elevated sections), the archaeological observations, the information regarding the state of conservation, the presence of gaps or collapses, to situations of potential danger (sagging, cracks, fissures, gaps, etc.) will be transposed.



Picture 5: example of archive documentations

Important techniques and tools of survey include:

PHOTOGRAMMETRY

Photogrammetry is a technique that allows you to determine metrically the shape and position of objects, starting from at least two distinct frames that take the same object (Stereoscopic Pair). This technique is used in cartography, topography and in architecture.

Photogrammetry, therefore, allows to identify the spatial position of all the points of interest of the object considered. This technique, although originally designed to be used in architectural surveying, is currently used for the most part for the topographical survey of the territory, developing mainly in the form of aerial photogrammetry.

The development of computers able to manage a large amount of data and computer graphics have allowed a simpler and faster use and with lower costs. In fact, the advent of these technologies has made obsolete old optical devices obsolete. Following these changes, photogrammetry is now also used in areas where it was rarely used in the past.

Picture 6: The analysis of the elevations and surveys aimed at the realization of the photo rectification of the structures (Archaeological Park of Castelseprio and Torba)

Currently photogrammetry represents one of the most reliable, economic and precise data acquisition techniques of the territory. It is very useful in analyzing changes in the territory.

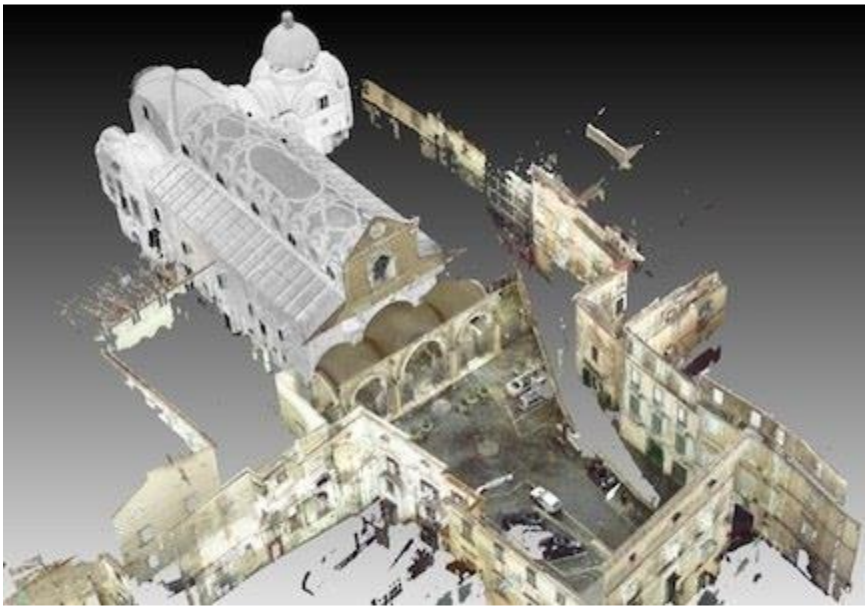
The first result of the photogrammetric survey is a cloud of points, which can be integrated with other 3D clouds generated by various relevant technologies such as the laser scanner and georeferenced with total station or GPS.

LASER SCAN

Laser scanner technology represents the most precise methodology to date for the cataloging of valuable archaeological assets, allowing the planning of the recording, analysis and archiving of data in a totally innovative way and proposing three-dimensional georeferenced digital surveys that can be connected to specific databases in in order to create easily questionable GIS.

The computerized processing of data allows immediate response to customer needs by providing highly customized services and supports. In addition to surveying and cataloging, the laser survey of an archaeological site allows the creation of a navigable three-dimensional model useful for creating a virtual excavation museum that can be consulted online by users. The high precision of the relief also allows the faithful reproduction of objects through the use of numerical control machines.

- possibility of operating with any return scale
- creation of critical tables on degradation
- creation of G.I.S. systems
- orthophoto
- 3D modeling
- documentation of the various stages of excavation progress
- creation of a navigable database



Picture 7: example of laser scan technology applied on a monumental complex

Environmental and hydrogeological context

In assessing the stresses to which a ruin is subjected, it is important to evaluate the environmental context. The preventive analysis of the environment can find a useful support in the hydrogeological studies already carried out, and in the seismic and water risk assessments. In urban areas, it is useful to have a sewage plan and the relative shares to locate the archaeological level with respect to the main dispersed or wastewater collectors. Faced with a modest initial investment, the implementation of drainages and protections on sensitive areas can allow a considerable economy of scale both at the conservative level and at the economic level. The natural phenomena that interfere with the research and maintenance of a ruin can, in fact, cause irreparable loss of information (eg flooding of an excavation in progress) and consequent economic losses (ie: the costs necessary to clear a flooded excavation to be able to resume the activity).

Constitutive materials

In the preliminary evaluation of the conservative intervention it is therefore necessary to carry out a qualitative and quantitative mapping of the constitutive materials present, to be reported on raised and raised surveys, to define the extent of the different types of intervention to be carried out.
Degradation related to the interaction between environmental context and type of materials
From the interaction between the parameters mentioned above (type of materials

and environmental context), the mechanisms of degradation specific to each ruin originate. If the preliminary examination of the two factors has been rigorous, it is possible to assess the most statistically probable risks and to take priority action on the combination of the factors that determine the maximum risk.

Through the fundamental investigation methodologies (optical microscopy, XRF, XRD, SEM-EDS etc.) we perform:

- complete characterization of stone materials, ceramics, pigmenting substances, metals and glass used in monuments, archaeological finds, historical buildings etc;

- study of ceramic materials, mortars etc. to identify the forms and products of degradation and to recognize the causes (natural and anthropic).

- identification of the historical quarries and / or the areas of origin of the raw materials and study of soils and paleosols.

PETROGRAPHIC ANALYSIS

By means of optical microscopy, petrographic studies of stone materials, ceramics, bricks, concrete, mortars, plasters and other industrial materials are carried out. In particular:

- petrographic classification of rocks in thin section according to the Normative Uni En;
- characterization of defects, superficial alteration patinas and other specific problems;
- image analysis of main components (matrix, included, aggregates, granulom curves) and estimation of porosity in thin section;
- dating of rocks in thin section;

Biological attack

To correctly evaluate the methodology to be applied on the ruderal vegetation, the following phases must be observed:

- analysis of the present flora;
- choice of treatment according to the type of vegetation;

• treatment modalities (period, product, doses)
• formulation of a long-term site control and management plan.

Picture 8: Plant growth over the ruined Abbey, Mourneabbey, Co. Cork, Ireland

For the long-term management of the site it is appropriate:

• avoid the accumulation of soil;
• consolidate and suture the wall or soil gaps
• avoid planting nearby pest species;
• plan periodic biocide treatments.

PREVENTIVE CONSERVATION INTERVENTIONS

Climate and humidity

If the ruin is exposed to atmospheric events, it is obviously not possible to control the climate that surrounds it. In this case it is of utmost importance to make drainages and coverings around and above the structures identified as "at risk" in the previous mapping, to avoid the imbibition of the foundations and walls, the migration and crystallization cycles of soluble salts, the washing out of the work in progress.

Picture 9: The standing remains of the Newstead Abbey (Englend), exposed to rainwater ingress and decay

Priority of the interventions

Based on the mapping of the materials and their interaction with the environmental context, a list of priorities of the consolidation interventions to be implemented will be established. This allows to define the time schedule required for the evaluation of the time and costs of the intervention.

THE INTERVENTION

The conservation intervention must be based on the following basic theoretical principles:

• Minimum intervention;
• Compatibility between original and restoration materials (chemical-physical composition);
• Reversibility of the action;
• Distincibility (technique of execution and treatment of surfaces);
• Respect of the vocation in relation to the performance capacity of the building or

site.

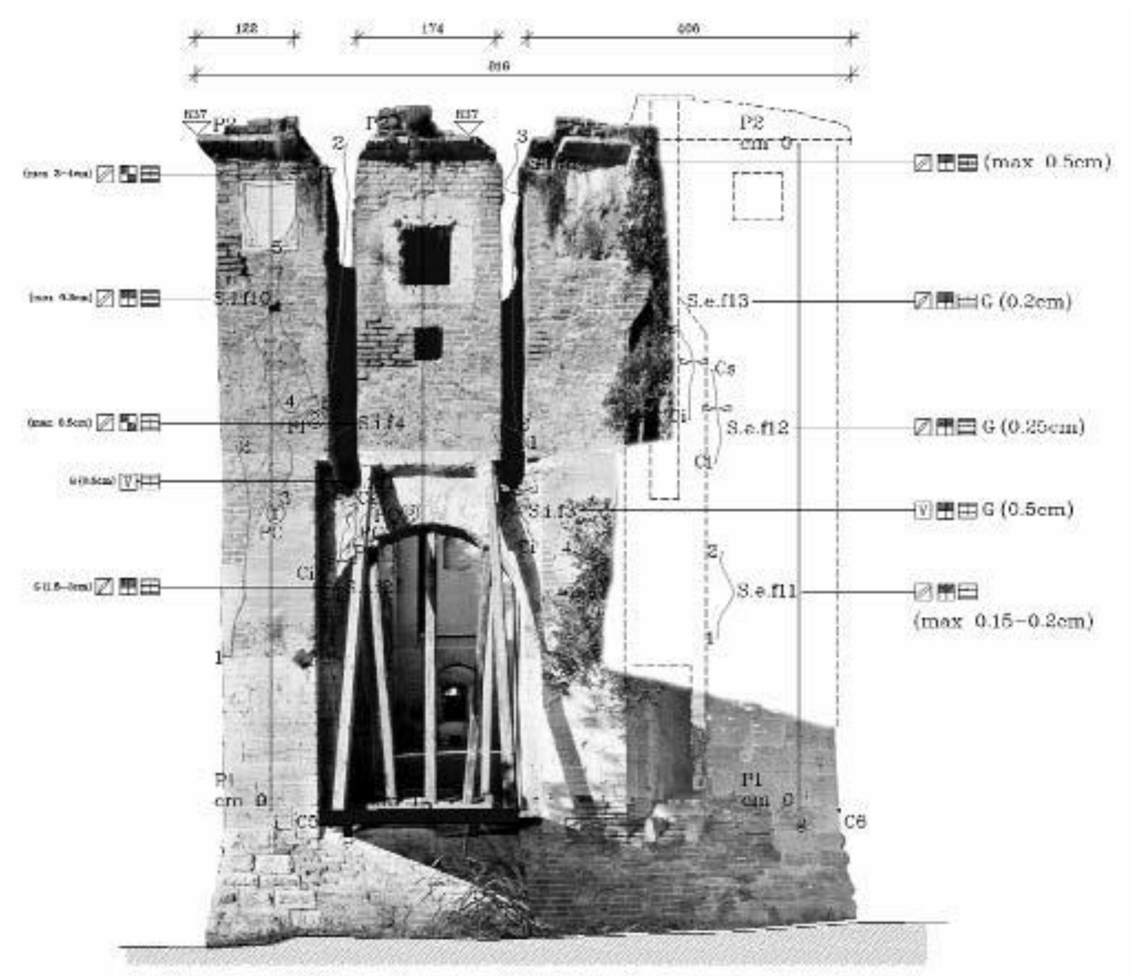
CONSOLIDATION

Consolidation refers to the series of operations aimed at "freezing" the conditions of the ruin in order to prevent or at least slow down further degradation as much as possible. It will therefore be distinguished in:

- Structural consolidation (improvement of static capacity);
- Cohesive consolidation (on decoesi structures or coatings);
- Adhesive consolidation (to restore continuity between coatings separated from the support).

Structural consolidation becomes a priority if some parts of the ruin are unsafe. If these carry coatings of historical and artistic interest, the static consolidation must be preceded (if it is possible to operate in safety) or immediately followed by the consolidation of adhesive or cohesive type. In general, the use of materials is required which:

- do not contain soluble salts;
- do not contain additives that can give rise to soluble salts;
- do not produce metal oxides;
- do not have excessive hardness or hardness higher than the original material;
- do not constitute impermeable barriers;
- ensure good vapor permeability;
- do not introduce changes in appearance (color, reflection of light);
- have stable color and transparency;
- are taken from the specific constructive tradition.



Picture 10: example of a survey

THE INTEGRATION OF THE GAPS

This operation must satisfy two main requirements: the mechanical protection of the product and the aesthetic participation in the comprehension of the whole. The integration must also respect some technical imperatives:

- physical chemical compatibility with the lacking material;
- reversibility;
- identifiability.

The methodology of additions is further differentiated according to whether it is carried out on:

- gaps in the walls;
- walls without cladding;

- plasters;
- painted plaster or decorative coatings;
- floors;
- decorated architectural elements (friezes, moldings, sculptures).

In general, and in compliance with the regulations contained in the Cards of the restoration, the limit between integration and original material must be clearly perceptible.

THE PROTECTION OF THE WALLS (COVER)

In the choice relating to the constitution of the covers does not only count the appearance, however, subordinated to the critical reading of the wall texture and the comparison with architects and archaeologists in charge of the project, but also related to its constituent materials and methods of implementation. In evaluating the many experiences made during the twentieth century and their state of conservation, we conclude that the covers should:

- to be largely composed of stone or brick similar to the masonry to be protected;
- be laid with the minimum required quantity of binder.

In the event that the covers are not covered by a layer of mortar, and their constituent material is therefore visible, the use of local stone or of local stone has been positively experimented on some ruins of the Valdostan area (Castelli di Cly, Ussel, Morgex). fragmented collapse to a module decidedly smaller than the original, so as to make easily identifiable the limit between protected masonry and protective masonry, underlined by a slight "sub-level".

It is useful to reiterate that the covers have a protective function and must be considered as a "sacrificial layer" whose hardness must be less than that of the masonry to be protected. Otherwise, the greater resistance to the environmental stresses of the covers does not prevent the deterioration of the underlying masonry, which is altered and must moreover bear the weight of the protection. On the basis of these considerations, for the binder materials the use of ordinary cement and derivatives (Portland cement, Pozzolanic cement, Calinto) and premixes of unknown composition are excluded.

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Municipality of Velenje (Slovenia)

„Protection and conservation of historical ruins"

VELENJE – ŠALEK CASTLE (EŠD 4329)

Compiled by:

ZVKDS (Institute for Protection of Cultural Heritage of Slovenia), OE (regional unit) Celje

Figure 1: Photo library of the ZVKDS Celje; photo by Danijela Brišnik

1. INTRODUCTION – HISTORICAL RUINS AS A MONUMENT (Danijela Brišnik, Tone Ravnikar)

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1. INTRODUCTION – HISTORICAL RUINS AS A MONUMENT

1.1. Monument description

The ruins of the Šalek Castle (German name: Schallegg) sit on a steep hill above the Šalek settlement. There is a tunnel under the ruins with a main road connecting the Šalek Valley (Šaleška dolina) with Mislinja Valley (Mislinjska dolina) and Slovenj Gradec basin. Today, the distinctive vista after which the Šaleška dolina is named consists of a tower with a triangular floor plan – remains of a strong tower core that was flanked by residential structures with a chapel. The tower is five storeys high. On the two most exposed sides, its walls are up to 2.50 metres thick. Only just under the top, the walls are thinner to form a walkable surface. Authentic window and door openings are preserved in its walls; however,

the frames, made of tuff, are severely damaged, or destroyed. In the top floors, the construction method still exhibits lamination tendency, while well-preserved cornerstones and architectural elements allow dating the construction of the building in the first half or middle of the 12th century. The castle is a result of many refurbishments and extensions. The castle burned down for the first time during the Raumschüssel dominion in 1676, after which it was thoroughly rebuilt and, judging from the smallscale archaeological material (large number of stove tiles), also considerably updated. In 1770, the castle burned down for the second time. After this fire, it has not been restored since and it started to deteriorate quickly, as it is already substantially in ruins in the depiction dating from 1830 (Old Kaiser Suite)[10].

1.2. Historical outline

The Šalek Castle was presented and analyzed by Ivan Stopar in four publications: *Grad in naselje Šalek (Šalek Castle and Settlement), 1975; Razvoj srednjeveške grajske arhitekture na Slovenskem Štajerskem (Development of mediaeval castle architecture in Slovenian Styria), 1977; Gradovi, graščine in dvorci na Slovenskem Štajerskem (Castles, Manors, and Mansions in Slovenian Styria), 1982;* and in his most recent book *Grajske stavbe v vzhodni Sloveniji (Castle Buildings in Eastern Slovenia), IV. knjiga Med Solčavskim in Kobanskim (Book IV: Between Solčava and Kobansko), 1993.* Šalek Castle was also featured in the monograph on Austrian

[10] Brišnik, Ravnikar 1999, pp. 30, 31.

castles by the Austrian castleologist Otto Piper, in the fourth book in the series published in 1905 under the title *Österreichische Burgen (Austrian Castles)*.

Old depictions preserved in a variety of collections are important for our knowledge of the castle's history. The oldest depiction of the castle dates back to around 1680. It was published by Georg Matthaeus Vischer in 1681 in *Topographia Ducatus Stiriae* under consecutive number 374.[11] This is also the only preserved depiction of the castle before it was abandoned late in the 18th century and before it began to deteriorate. There are several depictions from the 19th century. These are less detailed, but they are nevertheless important especially from a visual art perspective. They are also preserved in three collections of vedutas: S*tara Kaiserjeva suita (Old Kaiser Suite, around 1830), Leykamova suita (Leykam Suite, 1860) and Carl Reichert, Einst und Jetzt (1864)*. We note as an interesting fact that the triangular Šalek Castle tower still has its roof in the drawing from 1830, while on subsequent depictions the roof can no longer be seen. Three depictions of the castle in a study by Piper from 1905 are particularly important, as he drew very accurately and in detail the western and the eastern façade of the castle tower, and a detail of the staircase in the tower interior, which was still preserved at the time.

Figure 2: Georg Matthäus Vischer, Topographia ducatus Stiriae, Graz 1681

[11] In the Slovenian edition prepared by Ivan Stopar in 1971, the castle depiction can be found under consecutive number 104.

Historiography has paid too little attention to the issue of the Šalek Castle and the Knights of Šalek. Only Ignacij Orožen wrote somewhat more extensively on the subject in the fifth part of his history of the Diocese of Lavant, published in 1884 under the title *Das Dekanat Schallthal*. His history of the Škale Deanery also includes a brief description of the history of the Šalek Castle. Information in this work is outdated and therefore of little use. A much more currently relevant and up-to-date work is that of the Graz-based historian Hans Pirchegger, *Die Untersteiermark in der Geschichte ihrer Herrschaften und Gülten, Städte und Märkte (1962)*, which, however, is inadequate in its account of the oldest stage of the Šalek Castle, which, according to the documentary material and evidence, dates back to the 12th century. In addition, information about the history of the Šalek Castle can also be found in Hans Pirchegger's treatise *Die Herrschaften des Bistums Gurk in der ehemaligen Südsteiermark (1956)* and by Jože Koropec *Mi smo tu (1985)*. The latter includes an account of the peasant revolt of 1635 in which the Šalek Valley was one of the epicentres. The most important source for research of Šalek's mediaeval history, however, is the *Historična topografija slovenske Štajerske in jugoslovanskega dela Koroške do leta 1500, II. del (The Historical Topography of the Slovenian Styria and the Yugoslav part of Carinthia until 1500, Part II) (1988)* by Pavle Blaznik, in which pages 383 and 384 list most of the relevant references to the castle, knights, villages, and the St. Andrew's Church in Šalek. In recent years, mediaeval history of the Šalek Valley and therefore the Šalek Castle is the subject of study by Tone Ravnikar: *Velenjski meščani v 13. stoletju? (1992b), Šoštanjski vitezi ali vitezi iz Šoštanja v 13. stoletju (1992a), Gospodje Turnski v 13. stoletju (1992c), Posest grofov Vovbrških v Šaleški dolini (1993)*.

To this day, little is known about the earliest history of the Šalek Castle. We are certainly dealing with a very old castle, perhaps the oldest in the Šalek Valley area, as there can hardly be any doubt that both the Šalek settlement and the valley are named after the castle, , rather than vice versa. The name Šalek has been interpreted in several ways. The word is of German origin, consisting of two nouns. The word *Schall* means sound, and *Eck* means a corner. A rough translation of the word *Šalek* then would be *a corner with an echo*. The origin of the name could also be the Slovenian word *skale* or *skaline*, meaning *steps*, in relation to the neighbouring Škale – all the more so as the oldest records of both names are identical.[12]

Thus, we face one of the problems of studying the earliest history of the Šalek Castle, as the historical documentary material has to be delineated between Šalek and Škale. A review of the literature specified above shows this to be no easy task.

[12] Stopar 1975a, 4.

In 1975,[13] Stopar accepted the Knights of Šalek with some reservation, writing in the note that they most likely originate from "a somewhat mysterious Schalach Castle in Dovčja vas near Žihpolje in Carinthia". In the most recent part,[14] he revised this notion and suggested the first Knights of Šalek were the Knights of Škale who were the first secular lords of the Šalek Valley and therefore the Šalek Castle. Pirchegger makes no reference to them at all[15] and he clearly does not include them among the Knights of Šalek. However, Pavle Blaznik resolved this dilemma when he placed the parish priests Friedrich, Heinrich, and Ortolf who are referenced between the years 1173 and 1261, in Škale – the St. George's Church – while justifiably placing the knights Berthold, Dietrich and Hartnid in the Šalek Castle.[16] At first, the Knights of Škale were named The Knights of Turn, and they cannot and should not be confused with the Knights of Šalek.

According to Austrian historians, these knights originate from the Schalach Castle near Žihpolje, as the Brixen documents of the 11th century[17] refer to *Perehtolt* with hereditary estates in a town called *Sallach*, and he could be deemed a predecessor of the Knights of Šalek. It should also be noted that the old name for the town of Žihpolje (today, in German, Maria Rain) was Schallach. Thus, instead of the dilemma between Koroška (Carinthia) or Šalek Valley, the hypothesis that the Šalek Valley was colonized by the Nights of Carinthia appears more plausible, similarly as in the case of Šoštanj.[18] Adding to the plausibility is the fact that Dravski dvor from which the Knights of Šoštanj would originate, and Žihpolje lay in direct vicinity, neighbouring each other. At this point, we shall not go into more detail regarding the outlined issue; however, it should be underscored that there cannot be any doubt that the said yeomen Berthold, Dietrich, and Hartnid originate from "our" Šalek Castle.

We know that the St. Martin's Church in Šalek was built as a proprietary church of the Knights of Šalek, which would be impossible if this was not a free dynasty (with ministeriales of the Krško Diocese, as claimed by Pirchegger).

Understanding of the earliest history of the Šalek Valley requires knowledge of the broader area, bordering the castles of Celje, Heckenberg, Katzenstein and Vitanje. This is an area that Dušan Kos[19] calls the "explosive pot" as no major feudal dynasty was able to prevail and dominate here after the breakup of the great borderland (mark) estate in this area until the 14th century; rather, the estate was divided into many smaller, yet legally free and independent ruling houses. In the

[13] Stopar 1975a, 5.

[14] Stopar 1993, 92.
[15] Pirchegger 1962, 222ss.

[16] Blaznik,1988, 383.

[17] Jaksch 1904, No. 418, 165 and No. 422, 167.

[18] Ravnikar 1993, 23)

[19] Kos 1993, 38.

Šalek Valley area alone, we have identified three houses that only lost their libertine status at the end of the 13th century: Šoštanj[20], Turn[21] and Šalek. The Šalek estate included the north-eastern part of the Šalek Valley. In the west, it bordered the estates of the Turn Castle; in the north, it bordered the Huda Luknja Gorge and the Waldeck estates; and in the east, it bordered the Krško estates centred around the Ekkenstein Castle in the 13th century. In the south, it bordered the Velenje estates that were in the 13th century in the hands of the Kunšperk and were subsequently purchased in 1322 by the Ptuj dynasty that had already had some estates around the Velenje Castle in the 13th century.

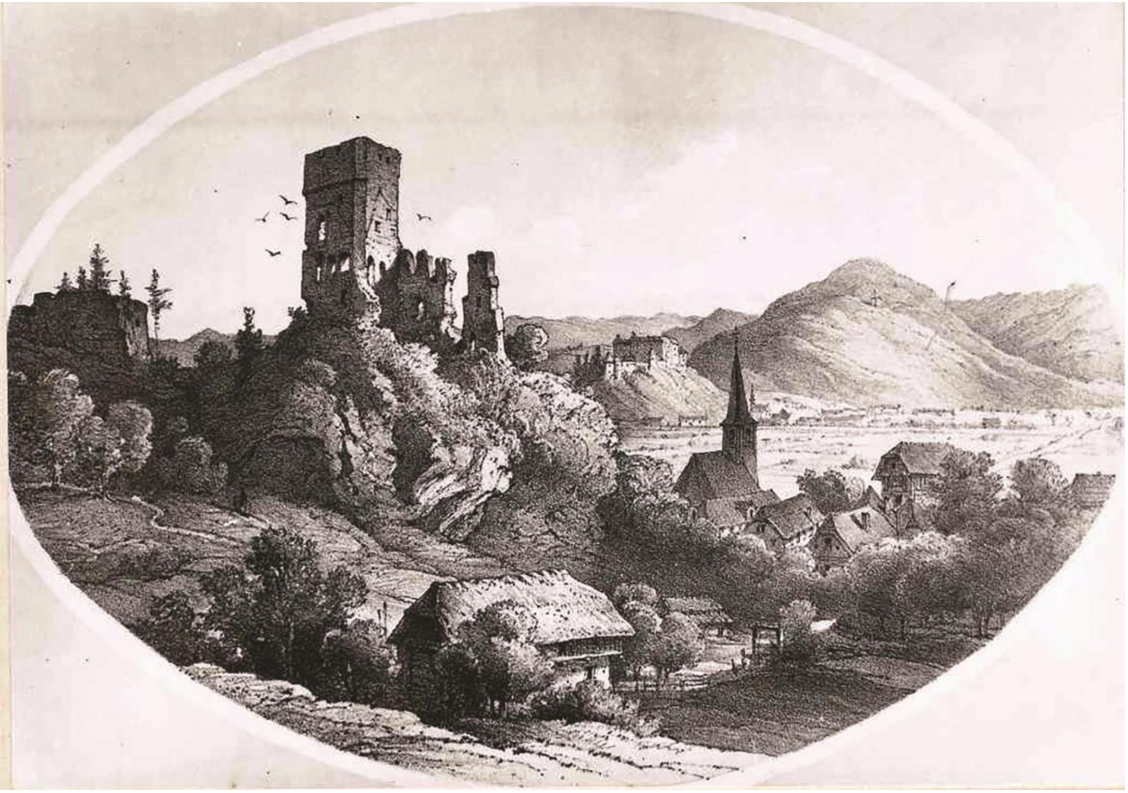

Figure 3: Reichert Suite, around 1864

It appears we are dealing with a small area of allodial land on which the Šalek dynasty built the castle and the proprietary church, the St. Martin's Church in Šalek. The claim that it was a proprietary church is based on a document created in 1264, which resolved a dispute between Egeloff of Šalek and the Gornji Grad Monastery regarding the rights to the Šmarje church. The dispute arose when in

[20] Ravnikar 1992a, 23ss.

[12] Ravnikar 1992b, 7ss.

1261, the monks of Gornji Grad acquired through trade the St. George's Church in Škale, the ancient parish church of the Šalek Valley, and the relations between the Škale church and the apostolic vicariate churches subjected to it had to be redefined. The first section of this document recognizes Egeloff's right of patronage to the St. Martin's Church, as well as the right to choose a suitable vicar for the church. The vicar had to be finally confirmed by the Škale parish priest to whom the St. Martin vicar was subjected.

Figure 4: Leykam Suite, around 1860

When the Šalek family lost their independence at the end of the 13th century, the St. Martin vicar, and later parish priest, retained a special position within the Škale Deanery, remaining directly subjected to the patriarch, rather than the Gornji Grad Monastery, until the erection and confirmation of the Ljubljana Diocese (Diocese of Laibach) in the 15th century. This document also indicates that Egeloff of Šalek acted fully independently in 1264, while the document from 1287[22] includes a promise by Siegfried of Šalek to the Krško bishop, his master, that he would not sell his rights to the castle to anyone without the bishop's permission. This can be interpreted as a vassal pledge by which Siegfried of Šalek acknowledge his ministerial relation with the Krško church. The same document also includes

[22] Wiessner 1958, No. 61, 41.

[14] Ravnikar 1992b,12 ss.

information that Siegfried of Šalek pledged his estates in Pilštanj (Peilenstein), including the villages of Cirkovce and Tremnik. It is interesting to note that their neighbours, the Turn dynasty, also had estates in Kozjansko.[23] It can be assumed with considerable probability that this similarity is not coincidental as we know that the mediaeval feudal dynasties were closely connected (including through kin, or familial ties), and we can –although merely hypothetical for the time being – consider the possibility of kinship between these two dynasties from the Šalek Valley.

After the vassal pledge and subordination of the Šalek dynasty to the Krško bishop, we also encounter Friderich and Wulfing who are named after the Šalek Castle. Both appear in the documents of the St. Paul Monastery. In all likelihood, at least Wulfing no longer resided in the castle, as indicated by the suffix *-er* in the dynastic name (Schallegger), which usually denotes members of a dynasty that carries the name of a castle but no longer resides in it. In 1314, Nikolaj of Šalek and his wife Adelheida sold the Šalek Castle to Otto and his wife Offmania of the neighbouring Ekenstein.[24] We continue to encounter members of the dynasty named after the Šalek Castle until the 15th century; however, they no longer played an important part in the history of this area.

Ekenstein Castle, managed by the Mertinger dynasty of which Otto referred to above was also a member, was the property of the Krško Diocese; it was held in fief by the Counts of Vovberg, and they in turn leased it to the Mertingers. After the extinction of the Vovberg dynasty in 1322, the Bishop of Krško granted enfeoffment of both dominions – Ekenstein and Šalek – to the Žovnek dynasty to whom brothers Niklas and Otto Mertinger pledged their loyalty in the same year. The Žovnek dynasty, later to become the Counts of Celje, kept the castle until their extinction in 1456. They leased it out to Niklas Kienberger in 1353 and to Mert of Rifnik in 1371, while in 1428 its possession was transferred to the Sebriach.[25]

It is interesting to note that Ahac of Sebriach, who is signed several times as Ahac of Šalek, completed university-level studies in Vienna, and became the Bishop of Trieste and one of the more prominent humanists and theologians of his time.

[24] Redik 1976, No. 706; 191.

[25] Pirchegger 1962, 223.

In 1575, the castle was inherited by the Raumschüssel dynasty who held it until 1695. Erazem Raumschüssel played an important part in the peasant revolt of 1635 referred to above. He protected the castle by supplying the revolting peasants with weapons, thus in a way even colluding with them. After the peasant uprising was quelled, he was tried at the court in Celje; however, his collusion could not be proven and he was exonerated of any guilt. During the Raumschüssel dominion, the castle suffered from the first fire (1676); however, it was apparently rebuilt, as it remained the seat of the dynasty in the next century. In 1695, the Šalek Castle was held by the lords of Gabelkhoven who also owned the Turn Castle in Škale. From that time on, the two dominions were merged. In 1770, the castle burnt down for the second time. After this fire, it was no longer restored and rapid deterioration ensued. *The Old Kaiser Suite* of 1830 shows the castle already severely damaged, with the roof only remaining on the central tower. Three decades later, the buildings around the tower were completely in ruins and only the tower continued to loom over the valley.

Figure 5: Šalek on a pre-war postcard (https:// sl.wikipedia.org/wiki/ Grad_Šalek, retrieved on November 5, 2017)

The image of the castle as it had been before it was abandoned is preserved in the Vischer copper engraving. Pressed against the perimeter of the strong tower core are residential structures and a chapel characterized by its ridge turret. Beyond the bridge over the castle ditch is a yard with three outbuildings. In today’s ruins, only the tower is preserved. Its floor plan has a triangular shape and it is still five stories tall. On the two more exposed sides over the defence ditch, its walls are up to 2.50 metres thick. Only just under the top, the walls are thinner to form a walkable surface. It allowed controlling access or entrances to the castle via battlements. The tower was connected from the very start to the *palas*, in all floors except for the top floor that rose freely above the roofs of the castle buildings that flanked it. Many authentic window and door openings are preserved in its walls; however, the frames, made of tuff, are worn down to such extent that they are hardly discernible from afar. Only a more detailed inspection revealed that the archivolts of the portals are semi-circular, indicating their construction in the Romanesque period. The well-preserved cornerstones, especially in the top floors, barely implied lamination in masonry, and particularly the preserved architectural elements allow dating the construction of the castle building in the first half or the middle of the 12th century, which is also consistent with the preserved documents. The castle architecture of course is not monolithic; rather, it is a result of numerous conversions and especially extensions. In its first appearance (or image), the castle most likely only included the tower with the *palas*. Gradually, new parts were added and as these were perhaps extended upwards, so the castle reached the scope seen in the Vischer depiction.

1.3. Legal grounds for protection

Protection of immovable and movable cultural heritage in Slovenia is regulated by the Cultural Heritage Protection Act (Official Journal RS No. 16/08, 123/08, 8/11, 30/11-SCD, 90/12, 111/13 in 32/16), which specifies the methods of cultural heritage protection and the powers and authorizations therein, in order to provide comprehensive cultural heritage preservation.

The term 'heritage' pertains to resources inherited from the past which Slovenes, members of the Italian and Hungarian ethnic communities, and of the Romani community, as well as other nationals of the Republic of Slovenia, determine to reflect and express their values, identities, ethnic identity (ZVKD1), religious and other beliefs, knowledge and traditions. Heritage includes features or aspects of the environment, which have been shaped over time by the interaction between people and place.

Heritage is divided into tangible and living heritage. Tangible heritage consists of movable and immovable heritage.

An integrated approach to heritage conservation is implemented through development-planning and other measures taken by the state, regions and municipalities, so that due regard is paid to the special nature of heritage and its social significance, and that sustainable development of heritage is provided for.

Monument of local significance

The Šalek Castle is entered in the Register of Immovable Cultural Heritage under the number EŠD 4329 (heritage reference number). The Register is an official database on immovable cultural heritage in the territory of the Republic of Slovenia. By entry into the register, every unit is assigned a heritage reference number (EŠD) used in all procedures of cultural heritage protection. As a monument of local significance, the castle is protected pursuant to the Ordinance on the Designation of Cultural and Historical Monuments in the Territory of the Velenje Municipality (Official Gazette of the Municipality of Velenje No. 10/83-75, 5/84-6). The ordinance on the designation (or proclamation) of the monument, which pre-dates the enactment of the Cultural Heritage Protection Act (ZVKD-1), specifies the regime of protection in such way that it is not possible to determine its scope; therefore, the monument is also subject to the general protection regime as specified in Article 134, Section 1, of the Cultural Heritage Protection Act (ZVKD-1), which provides as follows:

"individual monuments: protection shall apply to all external characteristics, such as gauges, designs of house fronts, ground plan arrangements, significant natural and artificial materials and construction characteristics, adequate intended use, characteristic appearance in space, archaeological layers, and proportions of the monument, and, in particular its area of impact. If the subject of protection as a monument is a historical park or garden, the protection shall apply to the park and garden design, the planting method, designed natural elements, and facilities and fixtures intended for use and embellishment."

One of the goals of developing the study "Protection and conservation of historical ruins – Velenje – Šalek Castle (EŠD 4329)" is also to lay down the groundwork for the management plan as specified in Articles 59 and 60 of the Cultural Heritage Protection Act (ZVKD-1). The owner or possessor shall manage the monument pursuant to the preservation decree directly, or through committing it to the care of a manager. A management plan shall be a document that lays down strategic and implementing guidelines for the overall conservation of a monument or site, and the method of implementing the protection thereof. The management plan shall be adopted in respect of all monuments and sites with a manager.

Article 59 of the Cultural Heritage Protection Act (ZVKD-1) (management of monuments)

- The owner or possessor shall ensure the management of the monument pursuant to the preservation decree directly, or through committing it to the care of a manager.

- All monuments that are protected on the basis of international treaties to which the Republic of Slovenia is a signatory, as well as all sites, shall have a manager. The preservation decree may provide for a manager also for other monuments.

- The authority which has issued the preservation decree may, pursuant to this act: directly manage the site by its own management unit; establish a public Agency for such a purpose; commit the management to the public entity which is established with the purpose of managing monuments and sites; or commit the management to a natural or legal person on the basis of laws governing public-private partnership.

- Management may be committed to a manager of a natural site if so provided for with the act on protection of a natural site, and if the manager possesses the technical competence for managing the site.

- Management of a monument or site shall be carried out on the basis of a management plan.

- If the manager invests his own funds in the restoration and maintenance of the monument, and takes on other burdens and risks, the authority that issued the preservation decree may conclude a concession contract on management with that manager, for a time period that is proportionate to the financial contribution and risks of the said manager.

Article 60 of the Cultural Heritage Protection Act (ZVKD-1) (management plan)

- A management plan shall be a document that lays down strategic and implementing guidelines for the overall conservation of a monument or site, and the method of implementing the protection thereof. The management plan shall be adopted in respect of all monuments and sites with a manager.

- The management plan shall be prepared by the manager, with the technical assistance of the Agency. The management plan shall be adopted by the authority that has adopted the preservation decree.

- The management plan shall contain at least:

    - a review of the cultural values which should be particularly conserved and developed,

    - a vision of protection and development,

    - strategic and implementing objectives of management,

- provisions which refer to the managing structure and measures for protection against natural and other disasters,
- a plan of activities, including the financial framework, in particular for ensuring accessibility and management of visits,
- indicators and the method of monitoring the implementation, and the time limit for the validity of the plan, along with a method of supplementing and amending the plan.

- In the case of the joint management of more than one territorially or contextually connected monument, a uniform management plan may be adopted for all such monuments.
- If a site and an area protected on the basis of laws from the field of nature conservation overlap, the management plan shall be adopted in agreement with the ministry competent for nature conservation. The organisation competent for nature conservation shall participate in the preparation thereof.

1.4. Values supporting the proclamation of a cultural monument of local significance

The Šalek Castle ruins, with relatively well-preserved original building substance and legibility of architectural remains (legacy), is an important source of information on the human past, and an area of interest for archaeological, art-historical, historical, and scientific research. They represent an important and recognizable dominant feature in the space at the passage from the Šalek Valley to the narrow gorge of Huda luknja. Its local importance is remarkable, and the same applies to its regional importance. At the national level, its importance is significant especially due to the rare and exceptional triangular shape of the central tower, and the fact that the entire valley is named after the castle, 1.4. Values supporting the proclamation of a cultural monument of local significance which is an exceptionally rare occurrence in the broader European area. Moreover, this is one of the earliest mediaeval castles in Slovenia to be the subject of at least partial systematic archaeological research, with the findings published in a monograph and presented at a permanent exhibition at the Velenje Museum.

Figure 6: Velenje - Grad Šalek (EŠD 4329) - orange: monument area, purple: monument area of impact (Source: RKD MK RS (Register of Cultural Heritage, Ministry of Culture, Republic of Slovenia) (October 5, 2017)

The Šalek Castle area of impact that includes the forest-covered slope up to the Golinov vrh was specified based on historical, functional, spatial, symbolic, and social aspect. Interventions into space and activities within this area should preserve spatial integrity, meaningfulness / expressiveness, and dominance of the cultural heritage.

In addition to the historical importance, specified in more detail in the historical outline hereinafter, the ruins of the Šalek castle also bear considerable scientific importance. Preservation and presentation of architectural remains allows examining the constructional development of the castle and life in mediaeval buildings or structures with a primarily defensive function.

Social significance of the Šalek Castle ruins lies especially in the identification of the local community with the distinctive and recognizable vista of the central triangular tower. The local community – Municipality of Velenje, Šalek Tourist

Society, Velenje Museum etc. – primarily provides care for the heritage, including long-term preservation, popularization etc. The castle also holds great potential for development of local tourism, especially cultural tourism, and as a source of formal and informal education.

Figure 7: Šalek Castle in 1992; Velenje Museum Archives

1.5. Protected elements of the monument:

- Historical, art-historical, archaeological, and spatial context of the site.
- The monument is protected as an indivisible whole in its appearance, originality, and unaffectedness.
- Protection shall include the original monument substance (construction material and construction design) and the functional design of the interior and the appertaining exterior space.
- Archaeological remains shall be protected on site (in situ) as an original place of deposit of their occurrence.
- Dominant location in the cultural landscape shall also be protected.

2. RULES OF PROTECTION AND PRESERVATION OF HISTORICAL RUINS

The protection regimes for immovable cultural monuments, archaeological sites, settlements and parts thereof, and the areas of influence, are summarized from the Manual of Legal Protection Regimes that have to be observed when preparing the plans and in case of interventions into the areas of cultural heritage, as developed by the Ministry of Culture of the Republic of Slovenia.

2.1. General protection regime for immovable cultural monuments

- promoting sustainable use of the monument, i.e. the use of the monument in such way and scope that does not result in loss of its cultural characteristics in the long run;
- promoting sustainable development of the monument that allows meeting the needs of the current generation without sacrificing the preservation of the monument for the future generations;
- promoting activities and conduct that preserve the cultural, social, economic, scientific, educational, and other aspects of the monument’s importance or significance;

- preserving the characteristics and social significance of the monument and its material or tangible substance;
- preserving the "protected elements of the monument";
- works on (or interventions into) the monument shall be allowed, which observe and preserve in the long run its protected values;
- interventions (works) shall be allowed, which allow establishment of permanent economic bases for preservation of the monument, subject to consideration of its special nature and social significance.

2.2. General protection regime for archaeological sites

Archaeological sites shall be protected from interventions (or works) or use that could damage the archaeological remains or change their substantial and spatial context. The following shall be prohibited in particular:

- excavation and backfilling of the terrain, deep ploughing, double-digging of trenching, melioration of agricultural (arable) land, construction of logging tracks (or timber lines);
- deepening of the sea bed and beds of watercourses and lakes;
- bottom trawling and anchoring;
- economic exploitation of minerals or rock, and erecting or building permanent or temporary structures, including above-ground and underground infrastructure, supports for advertisement or other labelling, except when this is necessary for efficient preservation and presentation of the archaeological site.
- In exceptional cases, interventions shall be allowed into archaeological sites which are at the same time building land within settlements, and into the space along the site perimeter:
    - if no other solution can be found or
    - if it is found based on the results of previous archaeological research that the land may be cleared for construction.

Any interventions and activities in the area shall be planned and executed in such way that the archaeological sites are preserved.

2.3. General protection regime for buildings

Protection regime shall apply for buildings, specifying the preservation of their protected values, such as:

- floor plan / layout and altitude design (gauges / dimensions);
- material (construction material) and construction design;
- exterior design (structuring of buildings and façades, shape and slope of roofing, roof cladding, façade colours, façade details including advertising boards, signboards and lighting fixtures which have to be consistent the design and contextual concept of the buildings);
- functional design of the interior and the appertaining exterior space;
- components and fixtures,
- doors, windows, and interior equipment;
- communication and infrastructural connection with the environment;
- appearance and vistas (especially in spatially exposed buildings);
- comprehensiveness of heritage in space;
- soil layers with potential archaeological remains.

In exceptional cases, the following is possible subject to prior consent by the relevant cultural heritage protection department:

- altering parts of individual structures or facilities to improve the quality or authenticity of their condition, based on prior conservation research;
- conducting scientific and research works;
- altering or supplementing the construction design if static stability of the structure cannot be ensured in any other way; however, all works (each intervention) has to maintain balance with safety assessment and minimum intervention that still provides safety and stability of the facility and results in the least damage to the facility's cultural value;
- interventions into the building environment to improve its presentation;
- allowing the presentation of the whole and individual protected elements, and public access to the extent that it does not threaten the protection of the

monument and its monument qualities, and that it does not disturb the activities conducted in it.

2.4. General protection regime for settlements and parts thereof

Settlements and parts thereof are protected in a way that maintains their protected values, such as:

- settlement concept (land allotment, communication network, layout of the settlement's open spaces);
- relations between respective buildings and relation between buildings and the open space (position, building density, ratio between built-up and non-built-up area, building lines, characteristic functional wholes);
- spatially prominent natural elements within the settlement or its part (trees, watercourses);
- distinctive position in the space of landscape (considering the relief characteristics, routes), natural and other vegetation boundaries, and perimeter of the settlement or its part;
- image of the settlement or any part thereof in space (architectural mass, gauges, roof shapes, roof cladding);
- relations between the settlement or a part thereof and the environment (vistas of the settlement views from it);
- building fabric (predominant building type, building intended use and capacity, street façades);
- equipment and use of public open spaces; and
- soil layers with potential archaeological remains.

2.5. General protection regime for the area of impact

- preserving spatial integrity, expressiveness, and dominance of the monument;
- preserving the traditional use, spatial relations, typical vistas and views;

- prohibition of any works or interventions with a negative effect on the appearance and character of the monument in the space or its material substance;
- prevention of planting of introduced (non-native) trees and shrubs, or other landscaping that is not consistent with the character of the monument and the space;
- it is forbidden to establish new spatial dominant features in the monument's area of impact;
- it is forbidden to introduce new contents that is in contrast with the contents of the monument;
- essential (defining) characteristics or properties of the monument shall be preserved.

The area of impact is also intended for permanent preservation of cultural values, advancement of the monument's expressiveness, preservation of the vista of the monument, and to educational and scientific and research work.

Pursuant to Articles 28, 29, and 30 of the Cultural Heritage Protection Act (ZVKD-1), protection conditions and protection approval shall be obtained from the Institute for Protection of Cultural Heritage of Slovenia (ZVKDS), and protection approval for research and removal of heritage shall be obtained pursuant to Article 31 of the ZVKD-1, issued by the Ministry of Culture of the Republic of Slovenia, for any works on (or intervention into) the monument, parts of the monument, protection areas or the monument's area of impact. Obtaining protection approval for research and removal of heritage pursuant to Article 31 of the ZVKD-1 shall be required for all works on or intervention into archaeological sites and soil layers with potential archaeological remains. When the main source of information is archaeological research or find, and such find can be assumed to have been buried under soil or under water for at least 100 years, and it has the characteristics of heritage, the requirement for obtaining the protection approval for research and removal of heritage pursuant to Article 31 of the ZVKD-1 is stipulated in the protection conditions, in consideration of the nature, scale, and contents of the planned construction works.

If an archaeological find is discovered in the area or object of such works (or intervention), the finder / property owner / other material beneficiary or person entitled under the law of property to the land / investor and responsible foreman shall make sure the find remains undamaged and at the location / site and in the position as it was discovered; and the find shall be reported no later than the next business day to the ZVKDS (Article 26, Paragraph 1 of the ZVKD-1).

2.6. Pre-emptive right to the real estate (right of first refusal)

The region or the municipality that proclaimed the monument shall have the pre-emptive right (right of first refusal) to the monument of local significance and immovable heritage in the area of impact of an immovable monument of national significance if that is so provided for in the preservation decree; if the state fails to exercise its pre-emptive right, the region or the municipality shall also have preemptive right to the immovable heritage in the territory of this region or municipality.

2.7. Obligation of public accessibility of the monument

The owner or the manager of the monument shall allow public access to the monument, proportionally to his abilities. Access may not endanger the monument or its protected elements.

When carrying out terrestrial excavations, the owner or possessor of immovable heritage shall, in order to protect the archaeological remains, allow access to an authorised person of the Institute to unfenced land, upon prior notification to the owner or possessor, as well as to fenced land and into all facilities except private dwellings, regardless of whether archaeological finds have been discovered or not.

2.8. Marking of the cultural monument

In order to improve public access, immovable monuments shall be marked. Marking shall be executed when this is not in conflict with the benefits of protection and other public interests. Marking shall also be executed as a form of protection in the event of an armed conflict on the basis of international treaties to which the Republic of Slovenia is a signatory.

The monuments shall be marked pursuant to the Rules and Regulations on Marking of Immovable Cultural Monuments (Official Journal of the Republic of Slovenia, No. 57/11):

- for better recognition, every monument shall be marked with a monument label pursuant to these Rules and Regulations.
- Monument label shall be a signboard on the monument front or other similar appropriate place. Its placement shall be deemed maintenance work.

- In exceptional cases, when required by the protection regime, the signboard may be placed on a special bracket in front of the facility.

- Placement of the board shall require a notification, pursuant to Article 28, Section 2, of the Cultural Heritage Protection Act (ZVKD-1). Application for the notification shall also include a drawing with proposed micro location of the signboard placement.

- In exceptional cases, when so provided in the preservation decree and when this is necessary due to the method of protection of the monument or parts thereof, particular archaeological or other monuments shall not be marked.

- Monuments included in the UNESCO list and monuments of European significance shall not be marked with a signboard as per these Rules and Regulations, but rather pursuant to the international decrees or acts specifying their status. They can, however, also be marked with a signboard pursuant to these Rules and Regulations.

2.9. Specific protection regime for the Šalek Castle cultural monument

Both general protection regimes and a specific protection regime shall apply to the monument: ***Requirements regarding monument protection, i.e. its regular maintenance, restoration, use***

a) Regular maintenance:

- regular monitoring by an authorized person or service;

- regular expert maintenance and restoration of the monument and parts thereof, and all evaluated and preserved original elements of architectural concept or design of the monument's exterior and interior based on the principle of preservation of the original location and position, form, structural elements, materials, and structures;

b) Restoration (works after occurrence of damage resulting from natural processes or excess intervention):

- documentingthe destruction;

- in case of damage to the monument of a part thereof, expert restoration shall be provided to restore the condition before the works or intervention, or to restore the original condition, at the expense of the person or entity who caused the damage;

- prohibition of changing the protected values of the original architectural design of the exterior and interior by demolition and removal;

c) Use:

- land shall be preserved in its current condition; any major works on (or intervention into) the monument, or its comprehensive restoration, shall require a conservation plan;
- providing appropriate purpose of the whole and particular parts consistently with the protected values of the monument and its basic intent or purpose;
- the management method employed to date shall be preserved; in exceptional cases, selective thinning of the forest shall be allowed, with professional timber haulage from the forest, under supervision by the relevant cultural heritage protection service;
- sanitation harvest shall be allowed, with professional timber haulage from the forest, under supervision by the relevant cultural heritage protection service;
- removal of root system by excavation of tree stumps shall not be allowed; removal with stump grinders, however, shall be allowed;
- collection and haulage of timber to existing logging tracks and hauling along existing logging tracks where existing logging tracks do not enable removal of timber shall be allowed in a time when the soil is frozen and the negative effects on archaeological remains are minimized. The relevant cultural heritage protection service shall be notified in advance about any planned works.
- Any damage to the archaeological site shall be immediately documented, and adequate protection of archaeological remains shall be provided.
- Prohibition of use of the monument for purposes that are not consistent with the aesthetic appearance, scientific, cultural, and educational contents of the monument

<u>Requirements regarding works / intervention measures:</u>

- Remains of structures, shape of terrain, and appearance (silhouette) of the site shall be preserved; any terrestrial works shall only be allowed in exceptional cases, i.e. in the process of scientific research and presentation, in the process of forest management plan execution, or in case of other public benefit, when all other options for placement of facilities of public interest have been exhausted. In such case, prior archaeological research or survey shall be provided.

- In case of complex works or interventions into the monument, or its comprehensive restoration, a conservation plan shall be prepared.
- Any works in the interest of scientific research shall be minimized, and in any case, a part of the protected facility shall be preserved as a control block.
- In case of functional updates to the facility and provision of disability access, protected elements of the monument shall be preserved to the greatest extent possible.
- In case of discovery of well-preserved remains that are culturally meaningful to the broader environment, these should be presented *in situ*, and appropriately integrated into the local tourist offer.
- Cost of presentation of discovered remains in situ shall in this case become a clearly recognizable and mandatory part of the mandatory post-excavation expenses of the archaeological site archive.
- Excavation, filling, or other interventions into terrain, except for the requirements of restoration of the castle ruins and its presentation, shall be prohibited.
- It is prohibited to construct any type of facilities, including infrastructural and utility lines, except for the requirements of restoration of the castle ruins and presentation thereof.
- Unauthorized persons shall not be allowed to use metal detectors and collect any surface archaeological finds.
- Erecting advertisement boards and other signs shall be prohibited.

In exceptional cases and subject to condition that protection conditions and protection approval, or expert bases are obtained, the following shall be possible:

- subject to prior archaeological research into the border areas of the protected area, place infrastructural facilities and utility lines; however, results of the said research may result in a change of the entire project.

Measures for protection from natural and other disasters, and in case of armed conflict:

- After the works that are allowed in the protected area based on the obtained protection conditions and protection approval, the terrain has to be restored to prevent erosion and landslide.
- Protected area shall be marked pursuant to Article 58 of the Cultural Heritage Protection Act (ZVKD-1).
- Protected areas shall not be included in any defence system or used for military training.

Measures for provision of access:

- Access with motor vehicles is forbidden, except for machinery required for the restoration of the castle ruins and presentation thereof, and for the needs of forest management.
- Public access to the facility shall be enabled in the scope or extent that does not threaten the protection of the monument or the owner's rights.

Protection regime shall apply in the area of impact, which shall specify:

- subordination of works to preservation, restoration, and refurbishment of protected characteristics of the space;
- preventing the open space from being built up by maintaining the traditional use of space;
- prevention of constructing permanent or temporary facilities or structures, including aboveground and underground infrastructure and stands (supports) for advertisement, except for the needs of monument presentation and in exceptional cases previously approved by protection approval by the Institute for Protection of Cultural Heritage of Slovenia (ZVKDS);
- prohibition of all works in the layer of area of impact, except to authorized persons subject to prior written approval by the Institute for Protection of Cultural Heritage of Slovenia (ZVKDS);
- In the monument's area of impact, the trees (forest and orchards) and the meadow slopes east of the castle shall be preserved in the current scope;
- shrubs and other vegetation on the south side of the tower may be removed to further expose the castle to view;

- protection conditions and protection approval shall be obtained prior to commencement of works for all works on residential buildings with ancillary facilities and direct surroundings in the monument's area of impact; since works have been carried out on such facilities without ZVKDS approval, these facilities have to be restored in terms of their shape, and the same applies to their surroundings.

Figure 8: Architectural drawings of façades of the Šalek Castle, 1992, archives of ZVKDS, regional unit Celje

3. PROTECTION OF THE MOST IMPORTANT STRUCTURAL ELEMENTS OF HISTORICAL RUINS

3.1. History of research and conservation works

Restoration and renovation works were carried out on the Šalek Castle in the years 1991 and 1992 under the auspices of the Velenje Museum (then operating as a part of the Cultural Centre Ivan Napotnik, Velenje), Department of Archaeology of the University of Ljubljana, and under expert supervision of the Institute for Protection of Cultural Heritage of Slovenia (ZVKDS), regional unit Celje.

Before (1966, 1974, 1998/90) and during (1991/92) archaeological excavations, accurate technical records of the Šalek Castle ruins were made, which are kept in the archives of the Institute for Protection of Cultural Heritage of Slovenia (ZVKDS), regional unit Celje.

NORTH FACADE *WEST FACADE* *EAST FAÇADE*

Figure 8: Architectural drawings of façades of the Šalek Castle, 1992, archives of ZVKDS, regional unit Celje

In 1995, preliminary results of archaeological research were presented at the touring exhibition “Particles of an everyday” at the Velenje Museum, which was organized in cooperation with respective Slovenian museums by the Department of Archaeology of the University of Ljubljana. Along with the exhibition, Velenje Museum worked with AV Studio, Velenje, to prepare an educational multimedia program “Life in Mediaeval Castles”.

In 1997, stove tiles (tiles from masonry heaters) from the Šalek Castle were published in the publication Archaeologia historica Slovenica 2 by the author Danijela Brišnik.

In 1999, conservation program for restoration was developed, which is the basic guideline for all works on the cultural monument; and the monograph Šalek Castle by Danijela Brišnik and Tone Ravnikar was published by the Cultural Centre Ivan Napotnik and Pozoj publishing company.

On October 19, 2001, Cultural Centre Ivan Napotnik informed the Institute for Protection of Cultural Heritage of Slovenia (ZVKDS), regional unit Celje, that it applied for the call for applications by the Ministry of Culture for renovation and restoration of monument characteristics on cultural monuments, proposing the restoration of the walls of the central tower of the Šalek Castle, and rebuilding / reconstruction of the missing walls and the roof.

On January 24, 2001, ZVKDS, regional unit Celje, issued to the applicant the protection approval for the restoration of the central tower’s walls, reconstruction of the triangular tower’s corner, and reconstruction of the tower roof.

On August 22, 2002, ZVKDS, regional unit Celje, issued to the Cultural Centre Ivan Napotnik Velenje the protection approval for further restoration of the north-western corner of the Šalek Castle tower and the adjacent walls, consistently with the conservation program for reconstruction and presentation of the Šalek Castle.

On November 24, 2003, ZVKDS, regional unit Celje, issued a protection approval for further works on the Šalek Castle: building of portals made of sandstone, construction of staircases and an observation deck, and construction of roof for the tower; however, these works have not been carried out.

After 2003, protection fences were erected on the ruin and, due to increasing vandalism, free access to the ruin was prevented, while archaeological finds were included in the permanent exhibition of the Velenje Museum, titled “Between the Romanesque and Baroque Period” by Tone Ravnikar, with cooperation of Danijela Brišnik.

3.2. Summary of archaeological research in 1991 and 1992[26]

Šalek Valley undoubtedly gets its name from the Šalek Castle ruins. Here, the Paka River gorge, squeezed between Stropnik and Špik-Kozjak, opens into an almost two kilometres broad and around eight kilometres long valley, transitioning form the drip stone-dolomite area to a tertiary area, while its watercourse turns from crosswise into longitudinal direction. Natural conditions of the Šalek Valley and its position in the natural transition to Carinthia allowed settlement as early as in the prehistoric periods. Nevertheless, the situation regarding archaeological research is poor as extensive archaeological research was only conducted on the castles Šalek and Šoštanj, and trial excavations were conducted on the Katzenstein Castle, Velenje Castle, and the St. Urh Church in Gaberke.

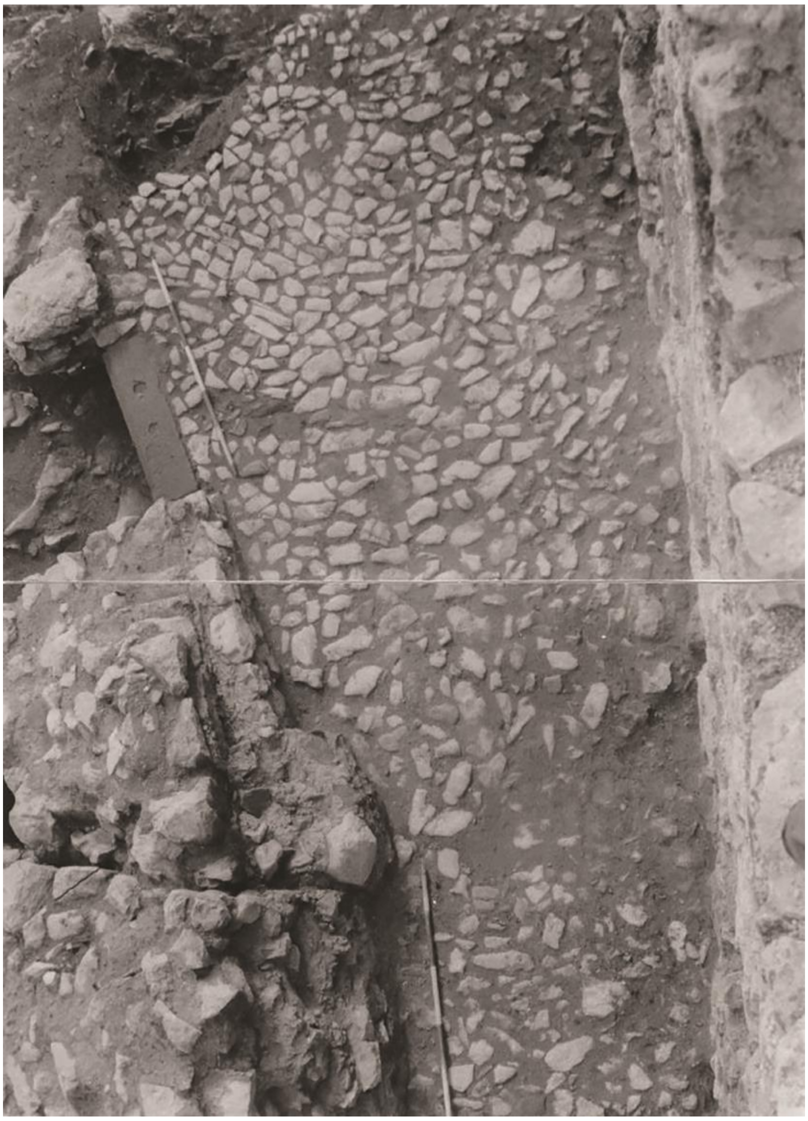

Figure 9: Discovered stone paving with preserved stone threshold, Velenje Museum Archives

[26] Synthesis summarized from Brišnik, Ravnikar 1999, with references listed there. References in this study only include those works that directly deal with the results of research on the Šalek Castle.

In 1991, excavation and restoration works on the Šalek Castle were focused directly on the surroundings of the triangular tower, in the scope dictated by the planned restoration works on the ruin. Archaeological excavation of cultural layers was carried out to the level of stone paving and masonry structures, while at some points excavations reached to the rock foundation. All finds were examined without consideration of archaeological stratigraphy of the site. Considering the opulence of finds and the obtained data that contributed notably to the understanding of the construction stages of the castle, archaeological documentation was carried out in 1992, including the selection of the position of control profiles along the exterior preserved lines of paving and in spots that allowed the best insight into the stratigraphy of the site.

Archaeological research has shown that the oldest wall on the steep rocky hillock (or monticule) is the wall marked SE 99, built in the east-west orientation, reaching under the northern corner of the triangular tower in the west, and under the walls of the so-called Space 1 in the east, which leans against the eastern side of the triangular tower. In Space 1, a very well preserved stone paving was discovered, as well as a structure interpreted as a small water tank shaped as a quarter circle (SE 51).All other discovered architectural remains in the eastern slope are of a later date. A smaller structure (Space 2) leans against the southern side of the triangular tower (SE 111); just next to this structure, stone staircase bridges the difference in elevation between the paved Zwinger and the passage in the wall (SE 33). On the western end of the castle plateau, southern foundation of the palas (SE 67) was discovered, in which a passage with a stone threshold and an arrowslit (or embrasure) are preserved. The wall is connected organically to the southern side of the triangular tower (SE 111); on the edge of the rocky hillock, it takes a right-angle turn towards north-east (SE 61).

Along the eastern side of the triangular tower (SE 15), along the deepening of profile in pure clay and less compact clay layer, fragments of very brittle, handmade ceramics were discovered. Approximately 0.40 metres apart, two longitudinal “pockets” filled with charcoal were observed in the profile, remains of a charred wooden structure. Since archaeological research did not continue in this area, interpretation is rather difficult. Considering the existence of an older wall SE 99 that – considering the current status of archaeological research – cannot be connected to the existing castle architecture, it is possible that we are dealing with prolonged continuous use of the space (an older – pre-castle stage); or the spatially constrained rocky hillock had to be reinforced before the Šalek Castle was built, or partially expanded with supporting or retaining walls, and even out the plateau with material brought from elsewhere. However, we still do not have a definite answer regarding the older ceramics that was made freehand and discovered at the Šalek Castle.

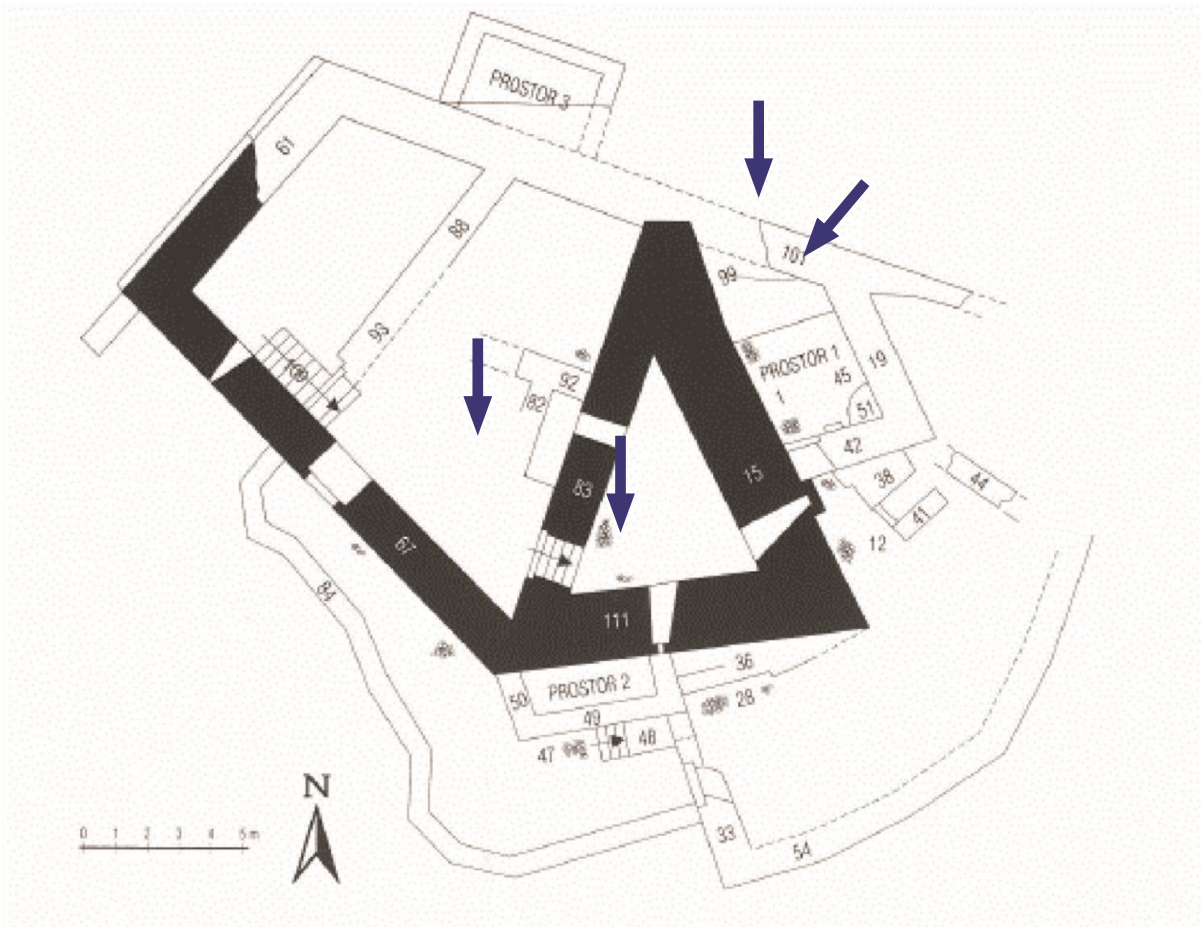

Figure 10: Floor plan of the Šalek Castle with marked discovered archaeological architectural remains, oldest wall SE 99, Space 1 and 2, and the southern foundation of the palas (SE 67) (summarized from Brišnik, Ravnikar 1999, p 35)

The most extensive set of archaeological finds discovered during the archaeological excavations includes the remains of stove tiles and ceramic pottery. Metal and glass finds are rarer and chronologically less definitive; numismatic finds are less telling because stratigraphy was not observed. Hence, the entire fond of materials was determined in 1999 based on the analogy in terms of form or shape with Slovenian and some foreign archaeological sites.

Oldest preserved stove tiles, placed in the late 14th and early 15th century, include fragments of nonpolished pottery stove tile made on a potter’s wheel, with bottom part shaped as a pot, expanding into a rectangular-shaped rim in the upper part. Dated only slightly later is the unpolished clad stove tile with a depiction of a dragon. A frequent motive for stove tiles from the last quarter of the 15th and from the 16th century is a framed oak leaf; also common in that period are stove tiles with the so-called wallpaper pattern. Particularly interesting in terms of colour are the stove tiles with a combination of *Figure 11: Virtual* blue and white, and green and white polish, made in the faïence technique, which indicates they were *reconstruction of the Šalek Castle, by Rok Poles, based* made by masters from the Mediterranean world.

Figure 11: Virtual reconstruction of the Šalek Castle, by Rok Poles, based on template by Ivo Gričar; ZVKDS, regional unit Celje

Kitchen pottery was found in many forms that were indispensable for food preparation and storage. Thus, pots of different forms are preserved, as well as lids, bowls, milk bowls, plates etc. The material dating ranges from the 13th to the

18th century. Standing out from the entire ceramics fond is a fragment of a pot with a non-profiled outward reaching lip, and shoulder embellished with a single wave line, made on a manual potter's wheel. By analogy, the fragment can be dated from the 4th / 5th to the 7th / 8th century, which again points to long-standing use of the space at hand.

Figure 12: Drinking goblet of the Celje type from Šalek, Velenje Museum Archives

Drinkware is represented with several fragments of chalices and goblets. Standing out among them is a goblet with four types of seals, i.e. drinking goblet of the Celje type, dated late 14th and 15th century.

Standing out among small objects from everyday life is a tiny folding sundial made of two ivory plates, between which a tread was strung as a polos. A compass was integrated into the lower plate, which sadly has not been preserved, while the cover features a gilded moondial with engraved markings. The watch is a representative of horizontal-vertical folding watches or the so-called Nurnberg compasses, dating from the 16th or 17th century.

Several coins have also been preserved, dated in the mediaeval period at the Slovenian National Museum. Moreover, some crossbow arrowheads, belt buckles, keys, needles, and glass objects have also been preserved.

Archaeological research has partly confirmed the image of the Šalek Castle from the Vischer copper engraving – residential structures and a chapel flanking the triangular tower, in a constrained space.

Figure 13: Ivory folding watch, Velenje Museum Archives

Preserved parts include the triangular tower with 2.50-metre-thick walls, foundation walls of the *palas* and smaller buildings of which the one along the eastern side (Space 1) has been tentatively defined as a kitchen due to the preserved chimney and water tank. Also preserved are the walls; however, no remains of a connecting bridge were discovered during the archaeological research, which connected the castle with the yard and the outbuildings on the Vischer depiction from 1681.

Construction sequence based on the results of archaeological research shows that the oldest built element on the rocky hillock is the wall marked SE 99, which was later integrated into the castle floor plan. It is not entirely clear whether these are remains of an older use of the space, or its purpose was to reinforce the very constrained space on the rocky hillock for subsequent construction of the Šalek Castle. Undoubtedly, traces of human life and work on the rocky hillock are witnessed by fragments of ceramics made freehand, pottery made on potter's wheel, and a pot dated in the early mediaeval period, long before the construction of the Šalek Castle.

3.3. General conservation starting points for the restoration of the Šalek Castle ruins

Stability and safety of the Šalek Castle ruin are of key importance for preservation of the cultural monument and for its revitalization, presentation, and popularization. Before all and any works on the monument or in its direct vicinity, the condition of the monument has to be assessed, which means that relevant documentation is to be produced with information about the architectural design of the building or facility, building techniques, damage, works carried out on the monument, and the facility's current condition:

- Adequate research has to be conducted, which includes research of the facility's history, events that caused particular damage (e.g. two fires in 1676 and 1770, respectively), and assessment of the condition of conservation works conducted in the past. Moreover, direct inspection of the facility shall be required to assess the current condition. Any damage shall be recorded and interpreted, which shall be the basis for an evaluation of the facility's condition. Upon inspection, the most threatened parts of the monument shall be determined, and procedures/research shall be specified that will allow acquiring as much data as possible. This research has to be based on non-destructive, or non-invasive, methods, i.e. methods with minimum intervention into the monument's original substance.

- Based on the assessment of the monument's condition, the scope and type of required measures for restoration / stabilization / presentation of architectural remains shall be determined. All works should be planned in such way that they do not alter the original design of building structure, that they involve minimum intervention into the monument's original substance, and that they are reversible to the greatest extent possible.

- All planned works or intervention into the cultural monument shall maintain balance with safety assessment and minimum intervention that still provides safety and stability of the structure and results in the least damage to the cultural value of the facility and related archaeological remains in the layers of soil. Moreover, the works should observe to the greatest extent possible the monument's primary design, construction techniques and original materials; therefore, new elements (staircases, service facilities etc.) should allow clear recognition of the original structure.

Figure 14 and 15: Presentation of the mediaeval church of Santa Maria Maggiore in Siponto, Italy (photo by D. Brišnik, personal archive)

- Original architectural substance shall be restored to the greatest extent possible, rather than replacing it with new substance. Deconstruction and subsequent reconstruction, or rebuilding, of the original substance shall only be allowed conditionally when this is required by the special nature of materials or structures, and when conservation is impossible or even harmful.

- Procedures that cannot be controlled during the works shall not be permitted. This is particularly important in case of protection of archaeological layers of the Šalek Castle. When restoring walls with injection, material (grout) is injected into the wall under pressure, causing it to spill uncontrollably into archaeological deposits, effectively flooding and destroying them. Therefore, walls should be restored or consolidated using techniques that do not include such negative effects on the immovable archaeological cultural heritage. Before any restoration and other works that involve terrestrial works, archaeological research has to be conducted in the stage of project documentation preparation, consistently with the monument's protection regime, in all areas where archaeological research has not yet been conducted.

3.4. General conservation starting points for the presentation of the Šalek Castle ruins

Despite the fact that the Institute issued in 2001 and 2003 the protection approval for roofing of the triangular tower, the decision for such protection of architectural remains requires thorough reconsideration. Starting from the fact that climate conditions in the area are highly unfavourable for preservation of the original wall substance (significant fluctuations of temperature and humidity, precipitation polluted with sulphur dioxides and nitrogen oxides etc.), roofing may seem the optimal solution for the preservation of the Šalek Castle's central tower. In such case, the walls would be physically protected for the long run, and new contents could be introduced into the tower. Assuming Vischer's depiction is sufficiently accurate and authentic, and that the professional conservators have at their disposal adequate information about the altitude of the last floor, and about the scope, appearance, and materials used for the roof, we cannot ignore the fact that rebuilding the roof would considerably change the vista of the Šalek castle, recognized in the consciousness of the Šalek Valley inhabitants as a ruin. It should also be noted that a structural engineering calculation as to whether the preserved ruins of the castle would even allow rebuilding the roof has not been conducted. Therefore, the Institute favours the presentation of the Šalek Castle as a ruin. Initial gauges and volume of the castle / tower can be at least partly presented with the use of modern transparent materials, similar to those used in the presentation of the mediaeval Church (basilica) of Santa Maria Maggiore in Siponto, Italy.

Currently, the castle can be accessed by foot along a route that is not historical. Therefore, it would be sensible in the long run to build access routes on this slope, past the former outbuildings, and to provide in this area the service facilities for provision of information, sale of tickets, toilets, souvenir shop etc. These facilities, as well as other elements in space (fences, boards, lighting fixtures, trash bins etc.) should feature a neutral design and be subordinated to the character of the monument and its presentation. Currently existing vegetation and terrain configuration shall be preserved in the largest extent possible. Before any terrestrial works (intervention into the layers of soil), archaeological research must first be conducted.

Figure 16: Partly restored and presented triangular tower of the Šalek Castle (http://www.rtvslo.si/slike/photo/142067/, retrieved November 5, 2017)

An observation deck can be constructed in the triangular tower. In this case, access to the observation deck should be provided using modern transparent materials in a way that recreates its full former appearance, or the tower’s architectural mass, without roofing. The structure of the observation deck should follow as closely as possible the historical floors, and it should be self-supporting to the greatest possible extent. Minimal integration of the structure into the original substance is acceptable; however, relevant cultural heritage protection service should first be consulted regarding the any such points of integration.

Shrubs and other vegetation on the south side of the Šalek Castle ruins should be removed to further expose the castle in the vista; moreover, this will result in partial recreation of the historical landscape of the rocky hillock that, when the castle was in use, was barren to provide safety.

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Venetian Heritage Cluster (Italy)

Report on the current state-of-art on protection, conservation and preservation of medieval ruins

Introduction

To form a comprehensive view on the status-of-art of the protection and conservation of the medieval ruins in Italy and of their contemporary use and re-use is not a simple operation, since the situation of this kind of relics is highly inconsistent and patchy, due both to political-juridical issues and to geographical factors.

In fact, even if the medieval ruins as a whole are subject, in order to be protected, to the Italian Code of Cultural and Landscape Heritage - Legislative Decree no. 42 of 22/01/2004 and subsequent amendments, the property of the remains can deeply diversify the way of protection and valorization of the medieval cultural heritage (FANTIN 2010)[27]. A great difference exists, for example, between the medieval ruins property of the State to those belonging to the ecclesiastical heritage or to the municipalities and also the valorization policies often reflect this difference.

Moreover, a real awareness of how many medieval ruins there are and where they are located, is still far to be reached. Some *corpora* have been developed in recent years, but they take into account just some "privileged" categories, such as castles and churches. Concerning the castles, are worth to be recalled the survey of the Italian castles promoted within the sites http://www.icastelli.it/ and https://www.mondimedievali.net/Castelli/index.htm and within other projects focused on regional or provincial heritages: in Trento district a website (http://www.castellideltrentino.it) and a series of edited books (POSSENTI 2013[a], POSSENTI 2013[b], POSSENTI 2013[c]; DEGASPERI 2015) take into account the issue of a survey of the castles, as well as in Bolzano district (https://www.suedtirolerland.it/it/cultura-e-territorio/castelli; da ultimo, TABARELLI 1982). Also in other parts of Italy, some projects have been recently carried out in order to survey the medieval heritage, with particular respect to the castles. Between the provinces of Parma and Piacenza, in the Renaissance part of an unique dukedom, the project "Castelli del Ducato di Parma e Piacenza" (http://www.castellidelducato.it/castellidelducato/castelli.asp) has been drawn up, albeit still missing of many ruins, mainly those not touristic developed; likewise, in the province of

[27] An interesting case study is the one in Noal di Sedico (Belluno), an archaeological site where the valorization of the remains had been for a long time stopped due to the private property of the area. The restoration and valorization works begun just after the heirs of the original owner granted the area to the Municipality for free (BIANCHIN CITTON, COZZA, DE VECCHI 2014).

Novara the on-line catalogue “Novara - I cento castelli” (http://www.centocastellinovara.it/castle) has been developed.

Generally speaking, it clearly appears how the awareness of the medieval heritage is still fragmented: beside some scientific and scholarly projects aiming a deep historic and archaeological knowledge of the castles (such as the one developed in Trento district), stand other surveys that strive just for the touristic development of some monumental castles, discounting a scientific awareness of them and of other ruins, albeit existing. The status-of-art concerning other typologies of medieval remains is even worse and more fragmented. For instance, with regard to the ecclesiastic architecture, the only scientific-based project is – as far as I know – the *corpus* named *CARE* (*Corpus Architecturae Religiosae Europeae*), which aims to index the whole European heritage of the ecclesiastic buildings built between the 5th and the 10th century. The project is still in development and for the moment just the first volume, devoted to the north eastern Italy (in particular, the provinces of Belluno, Vicenza and Padova) has appeared (BROGIOLO, IBSEN 2009). In general, it’s till reliable – even with some exceptions - the insight by Brunella Bruno (BRUNO 2005), who noted the difference in awareness and valorization of the cultural value of the medieval ruins in the different areas of Italy, with a specific difference among the Northern part, where the sensitivity about these issues is much heightened, and the Southern one.

More advances have been recently done in the field of the valorization of the archaeological – and, more specifically, medieval – ruins, also thanks to a deeper knowledge of the basic issues connected to *Public Archaeology, Experimental Archaeology* and *Participative Archaeology*. In the vast majority of the cases, in this field the medieval Archaeology and its efforts in order to valorize the medieval remains are by far a benchmark in the Italian scenario. Experiences like the system of castles and fortress in the Siena area (FRANCOVICH, VALENTI 2005) or the so-called ‘*Archeodromo*’ (see *infra*) paved the way to the spreading of some good practices within the valorization of medieval sites (MANACORDA, MONTELLA 2014; MONTELLA 2009).

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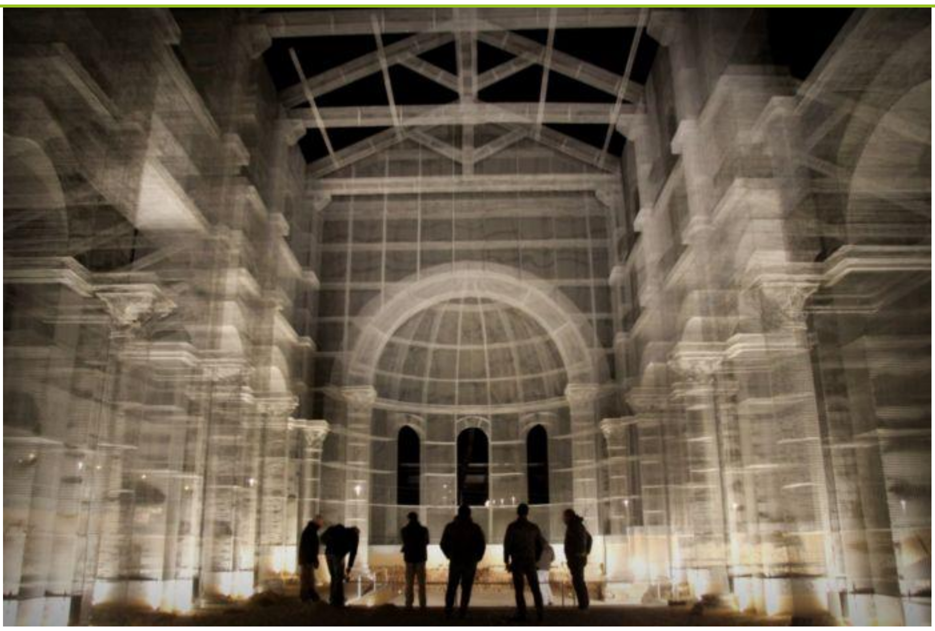
Building Name	**Santa Maria Maggiore Church** **(Basilica di Santa Maria Maggiore)**
Place	Località Lido di Siponto, Manfredonia (Foggia), Italy
Architectural type	Basilica church
Original Function	Place of worship
Period of construction	6^{th} century AD (first building, in ruin); 11^{th} century AD (second phase building)
Cause for the state of ruin	Abandonment of the city due to the disposal of the harbor and to the waterlogging of the area and moving of the inhabitants to the newly established settlement of Manfredonia.
Current function	The settlement of Siponto is marked by several moments of frequentation and abandonment. Thus, in the same place co-exist evidences of many different chronologies. At present, the only building surviving from the Middle Ages is the Basilica, built during the 11^{th} century, of Santa Maria Maggiore; it is one of the best known examples of the sacred Romanic architecture in Puglia region, and restoration works have been carried out in the last decades in order to assure its fully functioning as a church. Beside this architecture are located the relics of the paleochristian church, built in the 6^{th} century AD during one of the most wealthy periods for the city of Siponto. This part of the city, as well as the remains of the medieval city that surround the church, form an archaeological park, which greatly enhanced the number of visitors after the covering works carried out for the paleochristian church by the artist Edoardo Tressoldi, who in 2016 finished his reconstruction of the original volumes of the church realized with chain-link fence.
Intervention made in order to host the current function	Concerning the 11^{th} century church, a first phase of restoration has been carried out in the Seventies but it was not satisfactory to stop the progressive degradation of the building. In addition, some chemical alterations (such as, for example, some tannin foiling due to the use of oak bark compresses) started to run on the façade since that intervention onwards. Thus, a new restoration was needed and started in 2010 and ended in 2012. The works involved a deep cleaning of the stones, a consolidation of the medieval gateway and a complete coating with local stones of the upper and exterior

	parts of the church, that was degraded by heavy rainwater infiltrations. Focusing on the paleochistrian church and on the surrounding medieval quarters of the ancient city, the archaeological excavations were carried out since the early Nineties, and are still ongoing. In the meanwhile, restorations were run in order to consolidate and preserve the ruins, and to assure the touristic valorization of the site. The most relevant operation is indeed very recent, and is the covering of the ruins with chain-link fence, projected and realized by the young Italian artist Edoardo Tressoldi. While this installation allows to figure out the volumes of the original building, it is not impactor on the ancient structures and is completely removable and reversible. At the same time, it doesn't avoid a general view of the surrounding landscape.
Date of intervention	1970 onwards. Every year maintenance works are made in order to keep the ruin in good condition. In the next months, structural works will be carried out with the involvement of the relevant bodies such as the Polo Museale della Puglia. The medieval basilica, still in activity, is managed and maintained by the Diocesi di Foggia-Manfredonia.
Ownership and Management	The archaeological park is managed by the Polo Museale della Puglia and by the Soprintendenza Archeologia, Belle Arti e Paesaggio per le province di Barletta-Andira-Trani e Foggia and is protected by the Italian Code of Cultural and Landscape Heritage - Legislative Decree no. 42 of 22/01/2004 and subsequent amendments. The administration with the activation of ticket for the visit intends to guarantee the realization of interventions of protection, maintenance and enhancement of the monument. Every year several musical and theatre festivals are organized within and nearby the archaeological park and the medieval basilica. The medieval basilica is still in use a church, is owned by the Diocese of Foggia and Manfredonia and is accessible for free.

Images	 

	 
Source	• Caterina Laganara (a c. di), *Siponto. Archeologia di una città abbandonata nel Medioevo*, Foggia 2011 • Marina Mazzei (a c. di), *Siponto Antica*, Foggia 1999 • http://www.beniculturali.it/mibac/opencms/MiBAC/sito-MiBAC/Luogo/MibacUnif/Luoghi-della-

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Cataloguer	Eugenio Tamburrino_Sergio Calò

Building Name	**Complesso medievale di Castelseprio (Medieval complex of Castelseprio)**
Place	Castelseprio (VA) – Italy
Architectural type	Monastery, defensive building, settlement
Original Function	Settlement, with defensive and worship buildings connected
Period of construction	Since the 5yh century to the 11th century
Cause for the state of ruin	Between 1285 and 1287 the settlement was completely destroyed by the authorities of Milan involved in a war against the aristocratic family Torriani. The archibishop of Milan, Ottone Visconti, determined that the site had to be completely abandoned, with the exception of the two churches, that were kept in activity up to the 17th century.
Current function	The site is enclosed in the UNESCO list as part of the wide sites list concerning the occupation of Italian territories during the Longobard period. Actually the archaeological site is managed by several authorities, such as the Polo Museale della Lombardia - that runs the settlement, the *Santa Maria foris portas* church and the *castrum* area – and the private association *FAI – Fondo Ambiente Italiano*, that controls the near Monastery of Torba.
Intervention made in order to host the current function	The site has undergone a long-term process of excavation and restoration. In some cases, such as the little monastery devoted to the cult of San Giovanni, the ruins and buildings have been restored in order to host some touristic structures, such as the *Antiquarium*.
Date of intervention	The site focused the attentions of local scholars since the 17th century, but only since the Fifties of the last century the first systematic excavation and restoration campaigns started in Castelseprio. In the recent years, many restorations have been conducted, especially in the years since 2000 to 2014, in order to increase the touristic possibilities of the archaeological park.
Ownership and Management	The site is enclosed in the UNESCO list as part of the wide sites list concerning the occupation of Italian territories during the Longobard period. Actually the archaeological site is managed by several authorities, such as the Polo Museale della Lombardia - that runs the settlement, the *Santa Maria foris portas* churc and the *castrum* area – and the private association *FAI – Fondo Ambiente Italiano*, that contols the near Monastery of Torba.

Images	 

	
Source	• http://www.beniculturali.it/mibac/opencms/MiBAC/sito-MiBAC/Luogo/MibacUnif/Luoghi-della-Cultura/visualizza_asset.html?id=153930&pagename=157031 • http://archeologiamedievale.unisi.it/castelseprio • Paola Marina De Marchi (ed.), *Castelseprio e Torba – sintesi delle ricerche e aggiornamenti*, Quingentole 2013. • Angela Maria Ferroni, *Castelseprio-Torba nella lista UNESCO: un'opportunità in più per la valorizzazione dell'antico* castrum, in Paola Marina De Marchi (ed.), *Castelseprio e Torba - sintesi delle ricerche e aggiornamenti*, Quingentole 2013, pp. 627 – 636. • Angela Surace, *Il conventino di S. Giovanni: da convento francescano ad* Antiquarium, in Paola Marina De Marchi (ed.), *Castelseprio e Torba - sintesi delle ricerche e aggiornamenti*, Quingentole 2013, pp. 637 – 647. • Paola Marina de Marchi, *Castelseprio tra conservazione e valorizzazione*, in Paola Marina De Marchi (ed.), *Castelseprio e Torba - sintesi delle ricerche e aggiornamenti*, Quingentole 2013, pp. 653 – 656. • Monica Abbiati, *Castelseprio: la valorizzazione*, in Paola Marina De Marchi (ed.), *Castelseprio e Torba - sintesi delle ricerche e aggiornamenti*, Quingentole 2013, pp. 657 – 662. • AA. VV., Castel Seprio e Vico Seprio, aggiornamenti – Atti del

	Convegno, Milano 2002.
Cataloguer	Eugenio Tamburrino_Sergio Calò

Building Name	**Chiesa dei Santi Giovanni e Reparata** **(Church devoted to the Saints Giovanni and Reparata)**
Place	Lucca
Architectural type	Church and baptistery
Original Function	Worship place
Period of construction	The first phase of the building dates back to the paleochristian time, when the first worship building of the city was built since the 5th century to the 8th. This church had many construction and reconstruction works, for example with an important enlargement in the 9th century, when a new crypt was built in order to house the Saint Pantaleon's remains. In the 12th century a new church was overlaid to the paleochristian one, that was destroyed.
Cause for the state of ruin	Building of a new church
Current function	The paleochristian ruins are 2,20 meters below the level of the current church. Thus, the main issue the process of turning the ruins into an archaeological area had to face was the need to allow the current church to host the worship functions. Actually, in the late 90s the church has been deconsecrated and currently it hosts cultural events, exhibitions and conferences, as well as a stable exhibition of sacred art and artifacts.
Intervention made in order to host the current function	The paleochristian church has undergone a complete excavation process since 1969 to 1977, led by the local Archaeological Suprintendence. Since the early 80s to the 1992, the ruins were restored and the archaeological area was projected and realized. The archaeological remains are accessible at the underground level of the church, but are also visible thanks to some large 'windows' opened in the floor of the current church.
Date of intervention	20th century

Protection and Management	The ruins are owned by the Diocese of Lucca and ruled through the board *Complesso Museale e Archeologico della Cattedrale di Lucca*. The site is accessible throughout the whole year, and many touristic facilities are available, such as audio-guides and guides and cumulative tickets for the archaeological area and the other cultural sites owned by the Diocese. Spaces devoted to expositions, events and conferences are also available.
Images	 

	
Source	Giovanna Piancastelli Politi Nencini (ed.), *La chiesa dei Santi Giovanni e Reparata in Lucca*, Lucca 1993. Guglielmo Maetzke, *Una cronaca degli scavi*, in Giovanna Piancastelli Politi Nencini (ed.), *La chiesa dei Santi Giovanni e Reparata in Lucca*, Lucca 1993, pp. 187 – 190. http://www.museocattedralelucca.it/visiting.htm http://www.comune.lucca.it/turismo/chiesa_santi_giovanni_reparata http://www.museocattedralelucca.it/area_archeologica.htm
Cataloguer	Eugenio Tamburrino_Sergio Calò

6. CONCLUSIONS AND RECOMMENDATIONS

Both in practice and in the conservation theory, historic ruins have been identified as a specific group of monuments. The conservation theory defines the principles of dealing with ruins (the standard of the so-called permanent ruin), which may give the impression that the problem of separating, analysing, and protecting this specific group of monuments is already completely elaborated.

However, in reality it is not. Due to the detailed negative features of the historic ruin, the standard of protection of historic ruins in the form of the permanent ruins is not widely known and is not widely accepted.

It must be clearly stated that the majority of stakeholders – owners and managers of ruins, authorities, local communities, and public opinion (media) – prefers the reconstruction of ruins (bringing them to the cubature form). What is more, such an approach finds support in the conservation environment – in each case, the originator of the ruins restoration finds architects and conservators who justify and implement these activities.

Therefore, the conservation environment is obliged to develop and popularize such a standard of protection of historic ruins, which can be adopted by stakeholders – which determines its implementation in practice.

As part of the RUINS project, a standard/model of several documents should be developed, which should create an appropriate base for the protection of historic ruins.

It is necessary to develop the following publications and documents:

1. Model of documentation assessing the technical condition and needs of conservation intervention – the so-called Technical Assessment Card for Historic Ruins

2. Guide of technical studies of the historic ruin – Research and Equipment in the analysis of the Historic Ruins

3. Guides on the maintenance, management, and use of the historic ruin in the form of a Management Plan – the Historic Ruin Management Plan – Guide.

4. A doctrinal document for the protection of historic ruins – the Protection, Management, Use of Historic Ruins Card (based on the Protection Card of Historic

Ruins – adopted by the General Assembly of the Polish National Committee of ICOMOS on December 4th, 2012).

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RUINS

REPORT ON THE CURRENT STATE-OF-ART ON PROTECTION, CONSERVATION AND PRESERVATION OF HISTORICAL RUINS

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