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TALLINNA TEHNIKAÜLIKOOL
INSENERITEADUSKOND
Ehituse ja arhitektuuri instituut

**ARHEOLOOGILISTE MÄLESTISTE KAASAEGNE ARHITEKTUURNE KÄSITLUS
TOOLSE LINNUSE NÄITEL**

**CONTEMPORARY ARCHITECTURAL TREATMENT FOR ARCHEOLOGICAL SITES
BASED ON TOOLSE CASTLE**

MAGISTRITÖÖ
MASTER'S THESIS

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Contemporary architectural treatment for archeological sites based on toolse linnus

Lõputöö põhieesmärgid:

1. Uurida linnuste konserveerimise võimalusi, tavadid ja seaduseid ning võtta neid arvesse.
2. Teha Toolse linnuse digitaalne kaksik, modelleerida selle peale tema endine maht ning visualiseerida, kuidas inimene seda kohapeal nutiseadmega läbi liitralsuse kogeb.
3. Töö lõpptulemuseks on töö teoreetilist osa arvestav kombineeritud liitreaalsuse ja käigutee projekt Toolse linnusel.

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FOREWORD

This master's thesis was written as the graduation project for the Academy of Architecture and Urban Studies in the Department of Civil Engineering in Tallinn University of Technology. I formulated the topic „Contemporary architectural treatment for archeological sites based on tolose castle“ with the supervisor Üllar Ambos. The idea originally surfaced in the autumn of 2020, when Kimmo Sakari Lylykangas, the professor at the Academy of Architecture and Urban Studies, proposed a topic that involved the application of augmented reality to the ruins of an old church in Finland. The topic also included the creation of a 3d model of the existing object. I was interested in the topic, but developed it further in the Estonian context, because it was difficult to visit Finland due to the coronavirus.

I thank this master's thesis supervisor Üllar Ambos. In addition, I expresses gratitude to my parents Meta and Arlis, as well as my grandparents Eha and Jonas, for their support during my education. The diploma obtained is as much yours as it is mine.

Keywords: architecture, master's thesis, augmented reality, archeological site, castle, ruins

EESSÕNA

Käesolev magistr töö on koostatud Tallinna Tehnikaülikooli inseneriteaduskonna arhitektuuri eriala lõputööna. Sõnastasin magistr töö teema „Arheoloogiliste mälestiste kaasaegne arhitektuurne käsitus Tolose linnuse näitel“ juhendaja Üllar Ambosega. Esmane ideesähvatus sai alguse 2020. aasta sügisel, mil arhitektuuri ja urbanistika akadeemia professor Kimmo Sakari Lylykangas pakkus välja teema, mis oma olemuselt käsitles liitrealuse rakendamist vanale lagunenud kirikule Soomes, kusjuures mahtu kuulus ka objektile digitaalse kaksiku loomine. Teema pakkus mulle huvi, kuid arendasin seda edasi Eesti kontekstis, sest koroonaviiruse tõttu oli Soomes käimine raskendatud.

Täna magistr töö juhendajat Üllar Ambost. Lisaks täna kogu õpingute vältel saanud toetuse eest oma vanemaid Meta ja Arlist ning vanavanemaid Ehat ja Jonast. Saadud diplom kuulub sama palju teile, kui mulle.

Võtmesõnad: arhitektuur, magistr töö, liitrealus, arheoloogiamälestis, linnus, varemed

ABSTRACT

The current master's thesis is assembled as the fifth-year final work for integrated architecture study at Tallinn University of Technology. The master's thesis deals with the study of preservation of archeological sites and the application of AR technology to the sites by the example of Toole castle.

The author of this master's thesis proposes that there lies a concern behind the approach to preservation of less-preserved archeological sites because, as the time goes they seem to be less and less cared for and visited. Although there are limited resources available, the problem remains because, despite of technological advancements, the attitude towards preservation of these objects seems to be stagnated for several decades. The purpose of this study is to figure out how to apply augmented reality (AR) to derive more meaning out of less preserved archeological sites while they remain to be to commemorate the rich heritage and history they offer.

The master's thesis is divided into two parts – theoretical and practical. The first theoretical part consists of a qualitative research, where the approach to preservation of archeological sites in western culture is discussed by examining the origin and guidelines. In the second part reference projects are used to explain the nature, implementation, and opportunities of AR. The discussion concludes with a summary that explains how to apply the AR to archaeological sites in a two phase approach.

Following the theoretical discussion, a case study of the Toole castle's is done, which includes analysis of location, history and conservation. The object was selected as an example for the design part of this master's thesis.

The master's thesis ends with a solution that is based on the case study and the summary of the theoretical part, due to which the concept is divided into two phases. In the first phase the idea presented supports the common objective of preservation of archaeological sites. The second phase is the innovative part of this project, where the the first phase is improved with the aim of improving the experience for the visitor.

ABSTRAKT

Käesolev magistr töö on koostatud Tallinna Tehnikaülikooli arhitektuuri eriala integreeritud õppe lõputööna. Magistr töö raames on tegeletud arheoloogiamälestise säilitamise uurimisega ning nendele liitrealisuse (augmented reality, AR) tehnoloogia rakendamisega Toole linnuse näitel.

Autor tõstatab probleemi, kus eeldatakse, et vähem säilinud arheoloogiamälestise säilitamise lähenemisviisi taga on probleem, sest mida aeg edasi, seda vähem nende eest hoolitakse ning neid külastatakse. Vaatamata sellele, et ressursid on piiratud, püsib probleem endiselt, sest hoolimata tehnoloogia arengust, tundub, et suhtumine nende objektide säilitamisse on aegunud ning stagneerunud. Selle magistr töö eesmärk on välja selgitada, kuidas rakendada AR-i tehnoloogiat vähem säilinud arheoloogiamälestistele eesmärgiga ammutada neist rohkem tähendust, et mälestada nende rikkalikku pärandit ja ajalugu.

Magistr töö jaguneb kaheks osaks – teoreetiline ja praktiline. Esimesene ehk teoreetiline osa koosneb kvalitatiivsest uuringust, kus arutletakse milline on ja kust pärineb lääne kultuuriruumi lähenemine arheoloogiamälestiste konserveerimise ja säilitamise suhtes. Teoria osa teine pool selgitab AR-i olemust, rakendust ja sellega kaasnevat võimalusi analüüsides referentsprojekte. Arutelu lõpetatakse kokkuvõttega, kus selgitatakse, kuidas kahe etapilise käsitlusega rakendada AR-i arheoloogiamälestistele.

Pärast teoreetilist arutelu tehakse magistr töö projektlahenduse jaoks valitud objekti Toole linnuse analüüs, kus käsitletakse selle asukohta, ajalugu ning konserveerimist.

Magistr töö lõppeb projektlahendusega, kus on võetud loomingu aluseks objekti analüüs ning teoreetilise osa kokkuvõtte, mis tõttu on jaotatud kontseptsioon kahte etappi. Esimeses etapis esitatakse ideed, mille aluseks on seos ühise arheoloogiamälestise säilitamise eesmärgi ning AR kihistuse rakendamise vahel. Teises on selle projekti innovatiivne osa, kus arendatakse esimest etappi edasi eesmärgiga teha külastajale kogemust paremaks.

TABLE OF CONTENTS

EESSÕNA	7	4. ARCHITECTURAL SOLUTION.....	23
ABSTRACT/ABSTRAKT	8	4.1 FIRST PHASE – AR.....	23
1. INTRODUCTION	10	4.1.1 PHOTOGRAMMETRY	23
1.1 PROBLEM AND PURPOSE.....	10	4.1.2 DIGITAL RECONSTRUCTION OF FORMER VOLUME	24
1.2 STRUCTURE OF THE THESIS.....	11	4.1.3 AR EXPERIENCE	24
1.3 PROBLEM SOLVING TOOLS.....	11	4.2 II PHASE – IMMERSIVE AR	25
1.1.1 CHOSEN METHOD OF RESEARCH	11	4.2.1 THE WALKAWAY.....	25
1.1.2 THE TOOLS FOR DESIGN	11	CONCLUSION	38
1.1.3 RESEARCH QUESTION	11	KOKKUVÕTE.....	38
2. AR AS A NEW OPPORTUNITY FOR ARCHEOLOGICAL SITES	12	REFERENCES.....	39
2.1 PRESERVATION OF HISTORICAL ARCHITECTURE	12	EXTRAS	41
2.1.1 ORIGIN OF THE WESTERN ATTITUDE TOWARDS CONSERVATION	12	LIST OF GRAPHIC COMPONENTS	42
2.1.2 GUIDELINES FOR CONSERVATION & RESTORATION.....	13		
2.1.3 APPROACHES OF PRESERVATION.....	14		
2.2 AR APPLICATION IN ARCHEOLOGICAL SITES.....	16		
2.3 EXAMPLES OF AR APPLICATION TO ARCHEOLOGICAL SITES	17		
2.3.1 3D VISUALIZATION VIA AUGMENTED REALITY: THE CASE OF THE MIDDLE STOA IN THE ANCIENT AGORA OF ATHENS.....	17		
2.3.2 VIRTUAL RECONSTRUCTION OF LOST ARCHITECTURES: FROM THE TLS SURVEY TO AR VISUALIZATION.....	17		
2.3.3 THE CULTURAL AND ECONOMICAL IMPACTS OF USING VIRTUAL HERITAGE IN ARCHAEOLOGICAL SITES IN EGYPT.....	18		
2.3 THE OPPORTUNITIES OF AR.....	18		
2.4 CONCLUSION	18		
2.4.1 PHASE I – AR.....	19		
2.4.2 PHASE II – IMMERSIVE AR.....	19		
3. TOOLSE CASTLE	20		
3.1 SITE ANALYSIS.....	20		
3.2 HISTORY.....	21		
3.2.1 THE LATEST FLOORPLAN OF TOOLSE CASTLE.....	21		
3.2.2 CONSTRUCTION STAGES OF TOOLSE CASTLE	21		
3.2.3 LIST OF IMPORTANT EVENTS	22		
3.3 HISTORY OF CONSERVATION.....	22		

1. INTRODUCTION

Imbued with a message from the past, the historic monuments of generations of people remain to the present day as living witnesses of their age-old traditions. People are becoming more and more conscious of the unity of human values and regard ancient monuments as a common heritage. The common responsibility to safeguard them for future generations is recognized (The Venice Charter, 1964).

There are thousands of castle ruins in Europe and hundreds in Estonia (Eesti Linnused, 2021). There is an ongoing effort to maintain them in order to preserve information. Many sites are overlooked due to a lack of resources and the location of settlements such as cities, which attract the population away from the historical sites that are further away. (Eraldatud toetused, 2021)



Illustration 1 The ruins of Laiuse castle (Source: <https://register.muinas.ee/public.php?menuID=monument&action=view&id=23932>)

1.1 PROBLEM AND PURPOSE

In Estonia the general stance toward archeological heritage sites such as castle ruins is that developers and architects can only interfere according to special conditions imposed by heritage protection agency (Muinsuskaitseadus § 49 & § 50). As a result, there is an attempt to preserve and conserve majority of the castle ruins with delicate interventions and maintain them as a sightseeing objects.

There are many sites in Estonia that in their essence contain great beauty and potential for a person to experience, but they remain to be rather neglected places, because people prefer to visit more well known and preserved castles, such as those in Rakvere and Narva. The rationale for this could be that those sites contain more value in terms physical historical information and

have the infrastructure of the town/city around it. Still, there is an ongoing effort to preserve less popular sites as sightseeing objects in the hopes that people keep visiting them.

As the time passes, more and more sites need care, but the resources remain to be limited. Technology has developed to the point where there are additional inexpensive means that could be applied to support the common objective of preservation. There are several articles and journals published in the last years that reason the augmented reality (AR) application to heritage sites. This suggests the hypothesis that by applying AR to archeological sites, the common objective of preservation is supported, while also providing new experiences for the visitor. Possibly it would make less popular sites more attractive in a relatively inexpensive and quick way.

The purpose of this project is to figure out how to apply AR to derive more meaning out of less preserved archeological sites while they remain to be to commemorate the rich heritage and history they offer.

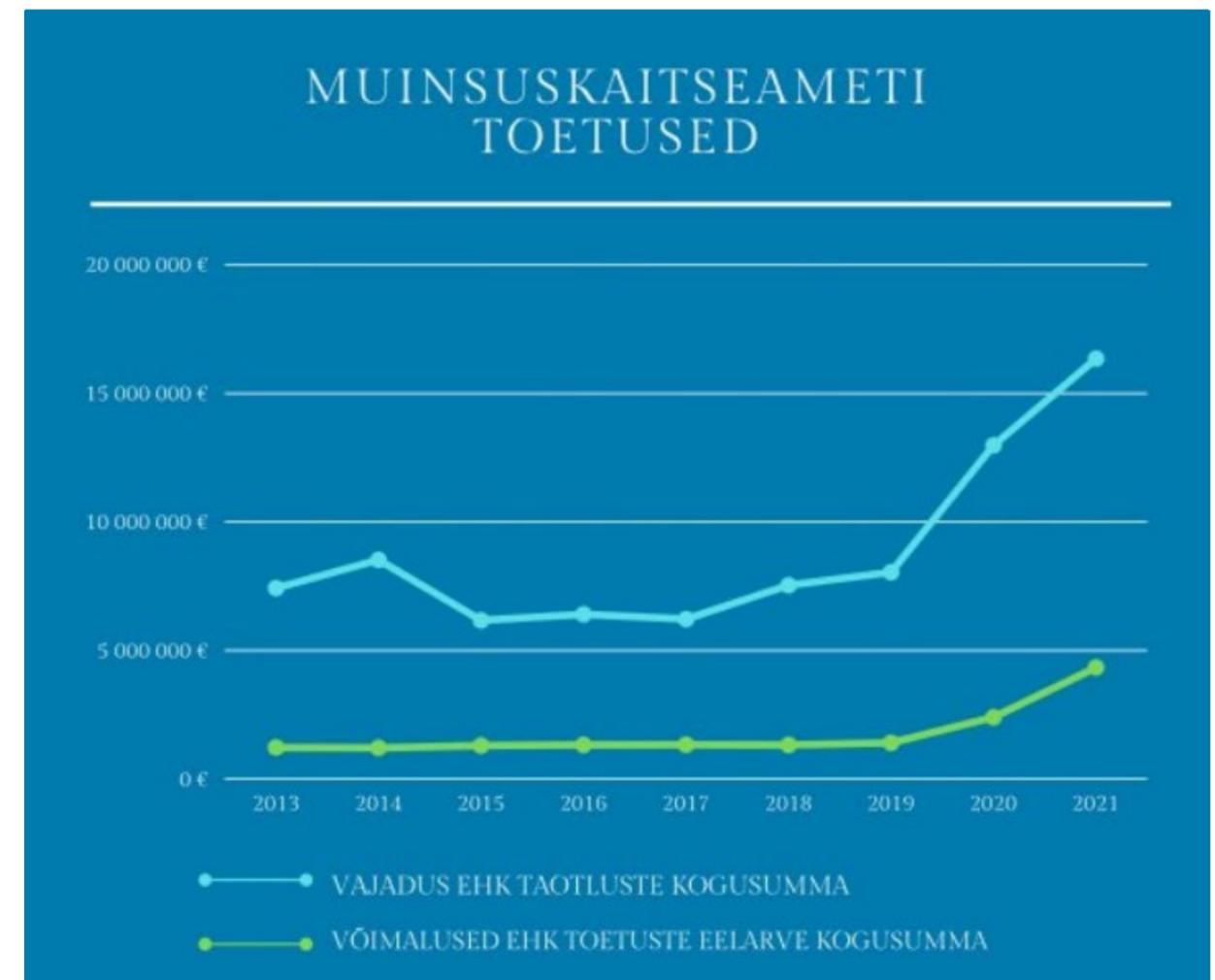


Illustration 2 Cultural Heritage Agency's financial assistance (Source: <https://www.muinsuskaitseamet.ee/et/jagatud-toetused>)

1.2 STRUCTURE OF THE THESIS

The master's thesis is divided into three chapters. The first chapter involves theoretical discussion, which consists of four parts. The first part describes history and principles of preservation regarding historical objects and their authenticity. In addition, examples of different approaches are introduced. The second part discusses what AR is and how it can benefit archeological sites and after reference projects are discussed. The fourth part concludes with author's concept of how could one successfully integrate AR to an archeological site.

Object analysis is the subject of the master's thesis's second chapter. The selection is explained and the context and history are described, while in the case of the latter, the various building stages and purposes of the parts of the last castle that was used in its intended purpose.

The architectural concept with AR application being the priority is presented in the third and final chapter, which is based on the intent of attempting to give new value to the castle while it remains to be and commemorate the rich history and heritage it offers – which, ultimately, makes the object more attractive.

1.3 PROBLEM SOLVING TOOLS

1.1.1 CHOSEN METHOD OF RESEARCH

The chosen method of research is qualitative. The theoretical discussion is based off data that consists of preservation, conservation, restoration, authenticity and AR technology. All the material used is available in the references of this master's thesis.

1.1.2 THE TOOLS FOR DESIGN

The information analysed and concluded in this thesis theoretical part and the case study of Toolse castle are both actin are tools that act as the basis for the architectural concept. For the design part of this project the following technology was used:

- DJI Phantom Pro V2 drone and Drondeploy software for photogrammetry;
- Archicad 24 Education version for modelling;
- Lumion 11.3.1 Student for rendering;
- Blender for computer generated imagery for videos;
- Microsoft Word and Microsoft powerpoint for presenting;

1.1.3 RESEARCH QUESTION

How to apply AR to derive more meaning out of less preserved archeological sites while they remain to be to commemorate the rich heritage and history they offer?

2. AR AS A NEW OPPORTUNITY FOR ARCHEOLOGICAL SITES

The problem and purpose of this thesis implies that the addressed object, castle ruins, which is an archeological site, where the AR would be applied, usually would be protected by law for example such as Estonia Heritage Conservaton Act. For an architect to figure out what kind of design approach to take regarding the castle, it is important to take into account western attitude towards conservation of such objects. Firstly, it is reasonable to be aware where does the the current western understanding of the act itself origin from, then get acquainted with international and local guidelines and figure out the common approaches across conservation field. After that the opportunities of AR for archeological sites are explored and then there is an attempt to find the connection between conservation and digital possibilities, because hypothesis of the topic implies that there is new value to be discovered when it is applied.

2.1 PRESERVATION OF HISTORICAL ARCHITECTURE

2.1.1 ORIGIN OF THE WESTERN ATTITUDE TOWARDS CONSERVATION

John Ruskin's *The Seven Lamps of Architecture*, published in 1849, is considered one of the cornerstones of today's heritage protection attitude. Intellectuals like Ruskin often emerge in search of compromise between the two opposites. In nineteenth-century England, it was there that the last time seemed to be a call for Ruskin to return to his roots. Because it will soon be too late, both due to the loss of craft skills caused by the Industrial Revolution and the disintegration-demolition caused by negligence, as well as the land-taking restoration fever. It is worth noting that in the opposite side worked the well-known architect and restorer Viollet-le-Duc, whose concept of restoration was that we do it closely, but we try to help and develop with modern materials. When writing „*The Seven Lamps of Architecture*“, he proceeded from the current issues of the time - the starting point of the "Seven Lamps" is the disappearance of the most earthly. (Jõekalda, 2014)

In the Chapter I, *The Lamp of Sacrifice*, he states that when one decides what is important to preserve in architecture, he/she should design it in a way that it would be possible to live in the era when the object was built and bring out the dignity born in that time. The social dimension in architecture should be taken into account - lifestyle, habits and practices.

In the next chapter, *The Lamp of Truth*, Ruskin says that, above all, there must be no lies in architecture. Materials must be

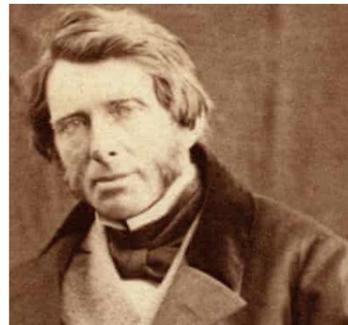


Illustration 3 The portrait of John Ruskin

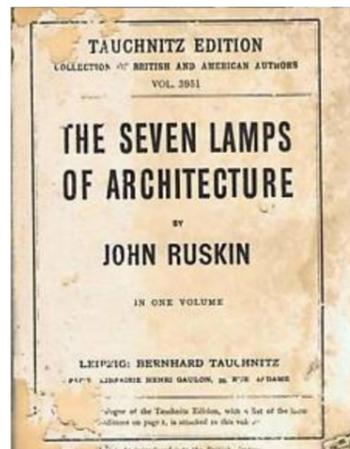


Illustration 4 The cover of *The Seven Lamps of Architecture*

genuine and honest, it must all be dignified. There must be no support elements that do not actually carry anything. One must get rid of fake beauty, fake constructions such as fake pillars that carry nothing. There must be no counterfeit materials, such as marbling or cladding. There should be no fake painting on a spruce tree as if it were an oak. The parts made in the manufactory no longer have a hand dimension inside. The stone as a material exists in this world for hand processing - every brick that is made with each hand and cast into a mold has a touch of hand and heat inside, which gives the building a special character.

In the third chapter, *The Lamp of Strength*, he states that an architect has to have a sense of composition, ingenuity, vigor of volumes, and a good sense of light-shadow balance in the design of decorative details necessary to achieve a majestic overall impression. The uplifting experience is guaranteed by scale, which is why Ruskin recommends abandoning the decor and scaling up a building where the landscape further enhances its impact.

In the fourth chapter, *The Lamp of Beauty*, Ruskin relies heavily on the designs seen in nature and points out that architecture should stem from the natural environment. Nature is the model for beauty. Lines and shapes should be derived from the natural world. The memory lamp, the most important guide in the current discussion of the subject, where it says that without architecture we would not be able to remember, architecture stores the essence of the era. Deep metaphors emerge in this chapters such as architecture stores the sound of music, architecture is hardened history, architecture is the presenter of history, architecture is the mirror of the work of raindrops. Famous idea is stated by Ruskin: „*Restoration means the most total destruction which a building can suffer. /.../ The thing is a Lie from beginning to end. You may make a model of a building as you may of a corpse. /.../ Watch an old building with an anxious care; guard it as best you may, and at any cost from every influence of dilapidation. Count its stones as you would jewels of a crown; /.../ bind it together with iron where it loosens; stay it with timber where it declines; do not care about the unsightliness of the aid; better a crutch than a lost limb; and do this tenderly, and reverently, and continually, and many a generation will still be born and pass away beneath its shadow.*“

Finally, in the chapter *The Lamp of Obidience*, he says that we must obey to history, we cannot highlight our personal whims. (Ruskin, 1849)

Those ideas are clearly opposite to the mechanized conveyor production of the Industrial Revolution at the time and during the operation of Viollet-le-duc, who restored according to his theories. Sought to create fictitious ideal situations in a historical architectural environment, the so-called creative reconstructions that did not really exist in the past, but could have existed in Viollet-le-Duc's opinion. Ruskin on the other hand stated that every original detail, every detail that has been baked in patina over time, or even reached its finishing or wear level, is worth ten times more than a copy of a room or building component or part of a building.

2.1.2 GUIDELINES FOR CONSERVATION & RESTORATION

International charters and conventions covering the rules specific to the Estonia can be found on the website of the Estonian Academy of Arts in the field of heritage preservation and restoration. (Rahvusvahelised hartad ja konventsioonid, 2021). The documents considered in this master's thesis are provided by International Council of Monuments and Sites (ICOMOS) - The Venice Charter (1964), The Nara Document on Authenticity (1994), Principles For The Analysis, Conservation And Structural Restoration Of Architectural Heritage (2003) and The Charter For The Interpretation And Presentation Of Cultural Heritage Sites (2008). In addition, Estonia's own legal guidelines, which can be found in the Estonia Heritage Conservation Act, are examined. Only the guidelines that are relevant to this master's thesis are highlighted, such as instructions for the preservation of and intervention to the castle ruins. The aim of this research is to gain an understanding of how to approach an archeological site within the context of the purpose of this master's thesis.

International Guidelines

Conservation

- Authenticity, considered in this way and affirmed in the Charter of Venice, appears as the essential qualifying factor concerning values. The understanding of authenticity plays a fundamental role in all scientific studies of the cultural heritage, in conservation and restoration planning, as well as within the inscription procedures used for the World Heritage Convention and other cultural heritage inventories;
- Conservation: all efforts designed to understand cultural heritage, know its history and meaning, ensure its material safeguard and, as required, its presentation, restoration and enhancement. (Cultural heritage is understood to include monuments, groups of buildings and sites of cultural value as defined in article one of the World Heritage Convention). (The Nara Document on Authenticity, 1994)
- The conservation of monuments is always facilitated by making use of them for some socially useful purpose. Such use is therefore desirable but it must not change the lay-out or decoration of the building. It is within these limits only that modifications demanded by a change of function should be envisaged and may be permitted.
- The conservation of a monument implies preserving a setting which is not out of scale. Wherever the traditional setting exists, it must be kept. No new construction, demolition or modification which would alter the relations of mass and colour must be allowed. (The Venice Charter, 1964)
- The value of architectural heritage is not only in its appearance, but also in the integrity of all its components as a unique product of the specific building technology of its time. In

particular the removal of the inner structures maintaining only the façades does not fit the conservation criteria.

- Deteriorated structures whenever possible should be repaired rather than replaced. (Icomos Charter - Principles for the Analysis, Conservation and Structural Restoration of Architectural Heritage, 2003)

Restoration

- The process of restoration is a highly specialized operation. Its aim is to preserve and reveal the aesthetic and historic value of the monument and is based on respect for original material and authentic documents. It must stop at the point where conjecture begins, and in this case moreover any extra work which is indispensable must be distinct from the architectural composition and must bear a contemporary stamp. The restoration in any case must be preceded and followed by an archaeological and historical study of the monument.
- Replacements of missing parts must integrate harmoniously with the whole, but at the same time must be distinguishable from the original so that restoration does not falsify the artistic or historic evidence.
- Additions cannot be allowed except in so far as they do not detract from the interesting parts of the building, its traditional setting, the balance of its composition and its relation with its surroundings. (Venice Charter, 1964)
- Restoration of the structure in Architecture Heritage is not an end in itself but a means to an end, which is the building as a whole.
- No action should be undertaken without having ascertained the achievable benefit and harm to the architectural heritage, except in cases where urgent safeguard measures are necessary to avoid the imminent collapse of the structures (e.g. after seismic damages); those urgent measures, however, should when possible avoid modifying the fabric in an irreversible way.
- No actions should be undertaken without demonstrating that they are indispensable.
- Each intervention should be in proportion to the safety objectives set, thus keeping intervention to the minimum to guarantee safety and durability with the least harm to heritage values.
- The design of intervention should be based on a clear understanding of the kinds of actions that were the cause of the damage and decay as well as those that are taken into account for the analysis of the structure after intervention; because the design will be dependent upon them.
- The choice between "traditional" and "innovative" techniques should be weighed up on a case-by-case basis and preference given to those that are least invasive and most compatible with heritage values, bearing in mind safety and durability requirements.

- Where possible, any measures adopted should be “reversible” so that they can be removed and replaced with more suitable measures when new knowledge is acquired. Where they are not completely reversible, interventions should not limit further interventions.
- The distinguishing qualities of the structure and its environment, in their original or earlier states, should not be destroyed.
- Each intervention should, as far as possible, respect the concept, techniques and historical value of the original or earlier states of the structure and leaves evidence that can be recognised in the future.
- Intervention should be the result of an overall integrated plan that gives due weight to the different aspects of architecture, structure, installations and functionality.
- The removal or alteration of any historic material or distinctive architectural features should be avoided whenever possible.
- Visual reconstructions, whether by artists, architects, or computer modelers, should be based upon detailed and systematic analysis of environmental, archaeological, architectural, and historical data, including analysis of written, oral and iconographic sources, and photography. The information sources on which such visual renderings are based should be clearly documented and alternative reconstructions based on the same evidence, when available, should be provided for comparison. (Icomos Charter - Principles for the Analysis, Conservation and Structural Restoration of Architectural Heritage, 2003)
- Authenticity is a concern relevant to human communities as well as material remains. The design of a heritage interpretation programme should respect the traditional social functions of the site and the cultural practices and dignity of local residents and associated communities.
- Interpretation and presentation should contribute to the conservation of the authenticity of a cultural heritage site by communicating its significance without adversely impacting its cultural values or irreversibly altering its fabric.
- All visible interpretive infrastructures (such as kiosks, walking paths, and information panels) must be sensitive to the character, setting and the cultural and natural significance of the site, while remaining easily identifiable.
- On-site concerts, dramatic performances, and other interpretive programmes must be carefully planned to protect the significance and physical surroundings of the site and minimise disturbance to the local residents. (The Icomos Charter for the Interpretation and Presentation of Cultural Heritage Sites, 2008)

Estonian guidelines

§ 49. Building design documentation and immovable monument activity plan

(1) An immovable monument or structure located on a heritage conservation area may be conserved, restored, constructed and transferred according to building design documentation.

(2) Building design documentation must comply with the requirements established for building design documentation and be in conformity with the special conditions for heritage conservation.

(3) An immovable monument or a structure located on a heritage conservation area may be conserved, restored, constructed or transferred or the appearance of a monument or structure located on a heritage conservation area may be altered according to an immovable monument activity plan if the nature, complexity and extent of the planned work enables it and if the submission of building design documentation is not required according to the Building Code.

(4) An activity plan shall be prepared by the person who performs the work. An activity plan includes the objective of work, performance schedule, the work method and extent, description of the used materials, technical drawings and illustrative material and, if possible, description of the condition of the monument or structure located on a heritage conservation area, conclusions of the conducted research and information on the previous conservation, restoration or repair works.

§ 50. Special conditions for heritage conservation

(1) The special conditions for heritage conservation are necessary for the preparation of building design documentation for the conservation, restoration, construction or transfer of an immovable monument or structure located on a heritage conservation area.

(2) The special conditions for heritage conservation are also necessary for the establishment or erection of a new structure on an immovable monument or heritage conservation area, except for in the case where the building design documentation follows the special conditions for heritage conservation of a valid detailed plan and a detailed plan approved with the Board.

(3) The Board issues the special conditions for heritage conservation with an administrative act except for in the case specified in § 61 of this Act. The objective of the special conditions for heritage conservation is to ensure the preservation of a monument or structure located on a heritage conservation area and parts thereof. (Heritage Conservation Act, 2019)

2.1.3 APPROACHES OF PRESERVATION

It is highlighted that Authenticity, considered in this way and affirmed in the Charter of Venice, appears as the essential qualifying factor concerning values. The understanding of authenticity plays a fundamental role in all scientific studies of the cultural heritage, in conservation and restoration planning, as well as within the inscription procedures used for the World Heritage Convention and other cultural heritage inventories (The Nara Document on Authenticity, 1994). It seems to be evident that the baseline characteristic of preservation is authenticity. The problem is that authenticity is difficult to define. In the guidelines it is explained that all judgements about values attributed to cultural properties as well as the credibility of related information sources may

differ from culture to culture, and even within the same culture. Thus it is not possible to base judgements of values and authenticity within fixed criteria (The Nara Document on Authenticity, 1994). For example, if one defines authentic as original then the characteristic is limited to the time of the artwork's creation: „original“ may only apply to the time that the piece was created, while „authentic“ does not. In terms of conservation, this difference has a major effect because it forces a much more nuanced view of the entity that includes all facets of its existence as opposed to an idyllic initial condition prized above any resulting normal ageing or alteration.“ (Cagriota, 2019)

Brian Cagriota (2019) has written: „Within this framework the authenticity of a manifestation is guaranteed as long as it maintains a critical mass of features discerned in consultation with the artist. As long as the particular properties, attributes, behaviours, relations, or conditions identified as significant or essential are sustained, it is thought that the authenticity of future manifestations will never be in question. Even in the eventual absence of the artist, if these attributes are preserved it is thought that the work's presence and authenticity might be assured.“ (Cagriota, 2019)

In conclusion, despite of existing guidelines, there are still different approaches that architects and conservators take when operating with archeological sites that involve castles, temples or churches etc and/or their ruins. Stephanie Auffret has said: „There is not one right approach; each case is unique and depends on what the artifact means to us, how we want to interact with it, and what story we want it to tell us and to generations to come“ (Auffret, 2019). Within framework of this master's thesis it is proposed that in general at this time there are four different attitudes towards conservation decisions:

- 1) First approach involves only conservation of the object. It aims to interfere and do as little as possible to preserve the maximum possible of an object's history. This seems to be the usual solution in the western culture for archeological sites such as castles. For example in Estonia, Rapla country with Angerja castle the ruins are kept as they are through time and only interfered with when theres a possibility for a larger scale collapse. As a consequence, maximum possible of the historical information remains and is possible for further study;



Illustration 5 The ruins of Angerja castle (Source: https://et.wikipedia.org/wiki/Angerja_vasallilinnus#/media/Fail:Angerja_linnuse_varemed.jpg)

- 2) *The second approach involves a combination of conservation and restoration.* Firstly, it aims to conserve and when the need arises then restore usually to it's original state that is defined by conservators. This approach aims to freeze an object in a specific state to tell the story of a given historical context. It seems to be usually applicated to a historic object that is still used in an everyday life, such as churches. For example, after the fire of Notre-dame church in France, theres an attempt to restore it to its former, latest state. As a consuequence while the aim is to conserve as much as possible, usually some historical information is lost.



Illustration 6 The conservation of the Notre-Dame de Paris chruuch (Source: <https://edition.cnn.com/style/article/notre-dame-cathedral-fire-anniversary-rebuild/index.html>)

- 3) The third approach is a combination of firstly restoration and then conservation. In the beginning the main goal is resotore an historical object and then it is conserved and restored in the first restored state. This approach, like second one, aims to freeze an object in a specific state to tell the story of a given historical context. For example, in eastern culture such as temples in Japan are treated in that way. The wooden material is replaced, when the need arises – this kind of treatment with historical objects is a taboo in western culture, but one would argue that authenticity still remains even without the original materials. As a consequence, its possible that most of the historical information in the case of physical material could be lost, but that is not always the case.



Illustration 7 The Kiyomizu-dera "Pure Water Temple" in Japan (Source: <https://en.wikipedia.org/wiki/Kiyomizu-dera#/media/File:Kiyomizu.jpg>)

4) In this master's thesis the fourth approach of preservation is defined as an independent restoration. One aims to restore the object into a new state. The goal is usually practical use, which means that for the architect there is an aim to reconstruct the object in a way that is useful for the client. In terms of aesthetics, one tends to place importance on the contrast between old and new material. For example, architects in Rocco Valentini Architecture office designed a project in Chieti, Italy with a combination of modern asymmetrical geometric volume and old historic material. With this approach of preservation, the historical content is preserved to the extent the restorer desires. (Auffret, 2019)



Illustration 8 The restored 19th-century home with a modern addition (Source: <https://archello.com/project/restored-19th-century-home-with-corten-addition>)

In our cultural space, the most common approach, at least regarding castle-like sites, is the first, which we call conservation. People who are responsible for preservation do and interfere as little as possible and support it whenever the need arises. It is reasonable to assume this kind of approach is understood as the one that happens to give the most authentic experience to the visitor of the site.

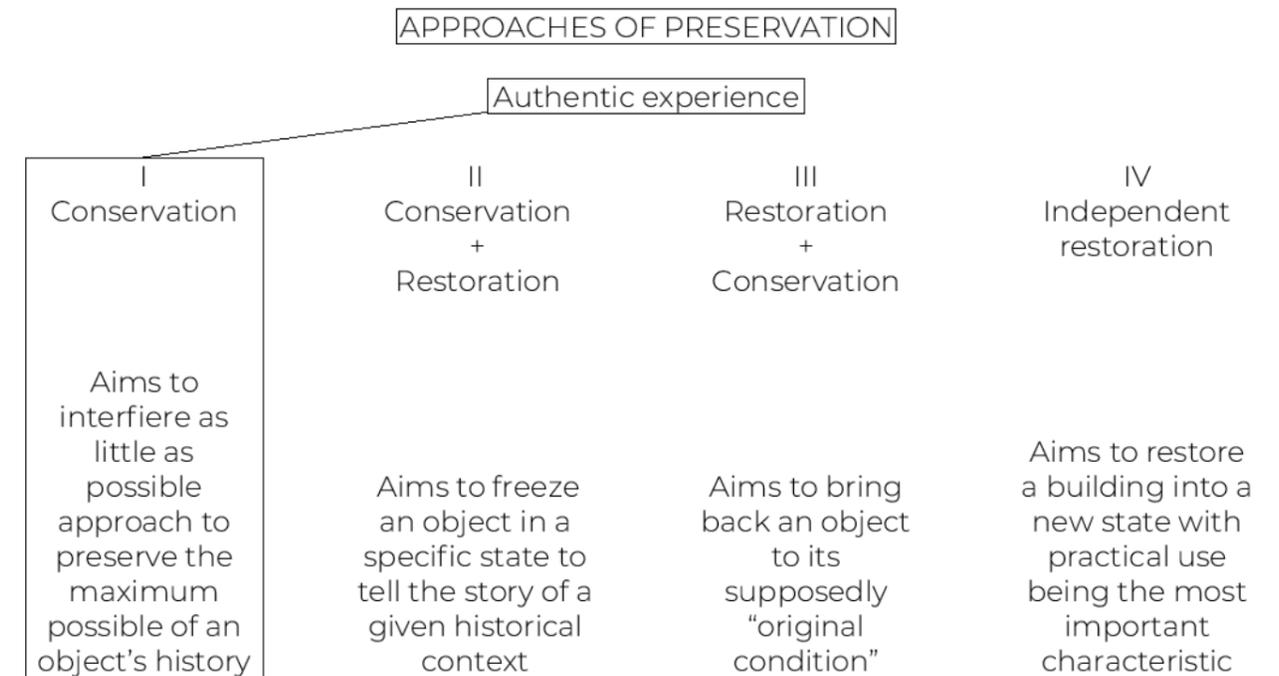


Illustration 9 Approaches of preservation (by author)

2.2 AR APPLICATION IN ARCHEOLOGICAL SITES

AR (AR) is a technologically enhanced version of the natural world that is achieved by the use of digital visual element, sound or other sensory stimuli. One of AR's primary aims, amidst the emergence of data collection and analysis, is to highlight unique aspects of the physical world, increase awareness of those features, and gain smart and open knowledge that can be extended to real-world applications. (Hayes, 2020)



Illustration 10 Example of Augmented reality on an archaeological site with a smartphone (Source: https://www.researchgate.net/figure/Tourist-sees-augmented-reality-through-his-tablet-author_fig4_325049910)

2.3 EXAMPLES OF AR APPLICATION TO ARCHEOLOGICAL SITES

2.3.1 3D VISUALIZATION VIA AUGMENTED REALITY: THE CASE OF THE MIDDLE STOA IN THE ANCIENT AGORA OF ATHENS

This project presents a virtual reality framework that enables the visualization of a portion of the Middle Stoa in the Ancient Agora of Athens, which is one of the most important archeological sites in the region. It is believed to be laid out in the 6th century B.C and it was a multifunctional commercial center of the city. At this time, only some parts of the constructions of it are visible in the site.

Users of the augmented reality software that was made within this paper will see what the building looked like in ancient times by pointing the camera of a smart device at the scenario. The device displays the three-dimensional model on the camera view of their screen, projected on the modern-day ruins.

The 3D digital reconstruction was performed using Autodesk 3ds Max software, according to the studies made by relevant abd drawings available. In cases where the information was scarce, the advice and suggestions of relevant scientists were applicated. The 5 megabyte 3D model was loaded in the AR application in OBJ file format. The results were satisfactory. The orientation and placement of the model was good, but due to the computational burden, big file size and high resolution of the video the frame rate was rather low.

The paper conluded that implementing AR to archeological site should attract peoples interest and increase the frequency of their visits to the site. By developing this application, the power of AR visualization of cultural heritage was shown and the fact that the software can be used to engage and retain visitors of all ages and educational levels was emphasized. (Verykoku, Ioannidis, Kontogianni, 2014)



Illustration 11 An example of Augmented reality on archeological site (Source: https://www.researchgate.net/publication/268075850_3D_Visualization_via_Augmented_Reality_The_Case_of_the_Middle_Stoa_in_the_Ancient_Agora_of_Athens)

2.3.2 VIRTUAL RECONSTRUCTION OF LOST ARCHITECTURES: FROM THE TLS SURVEY TO AR VISUALIZATION

This project reasons the fact that although AR systems have proved to be useful for Archaeological and Architectural Heritage's, it is not enough diffused, because of the advancements of technologies relevant offer the potential to make AR systems more useful to visualize high quality 3D data. The developers discuss and demonstrate their approach with the application of AR to Roman Theatre of Fanum Fortunae in Italy.

The first step of development was the architectural survey and positioning of material in the Archefano project. It was carried out by using a Terrestrial Laser Scanner (TLS) survey, which enabled the virtual reconstruction, where archeological samples, geometrical survey, praxis and theory of roman architecture were taken into account. The final step of this project was the AR and development, where it was brought up that a device like AR glasses immersify the experience.

In conclusion, within this project it was highlighted that up until today AR has been rather expensive for most institutions, but thanks to benchmarking several AR engines, the creation of these applications has become easy, relatively fast and inexpensive. On the other hand, it is also noted that at this time, the hand-held devices are still a bit too weak to handle complex or high quality digital representation, which means that the immersive experience is not possible at the highest level. (Quattrini, Pierdicca, Frontoni, 2016)

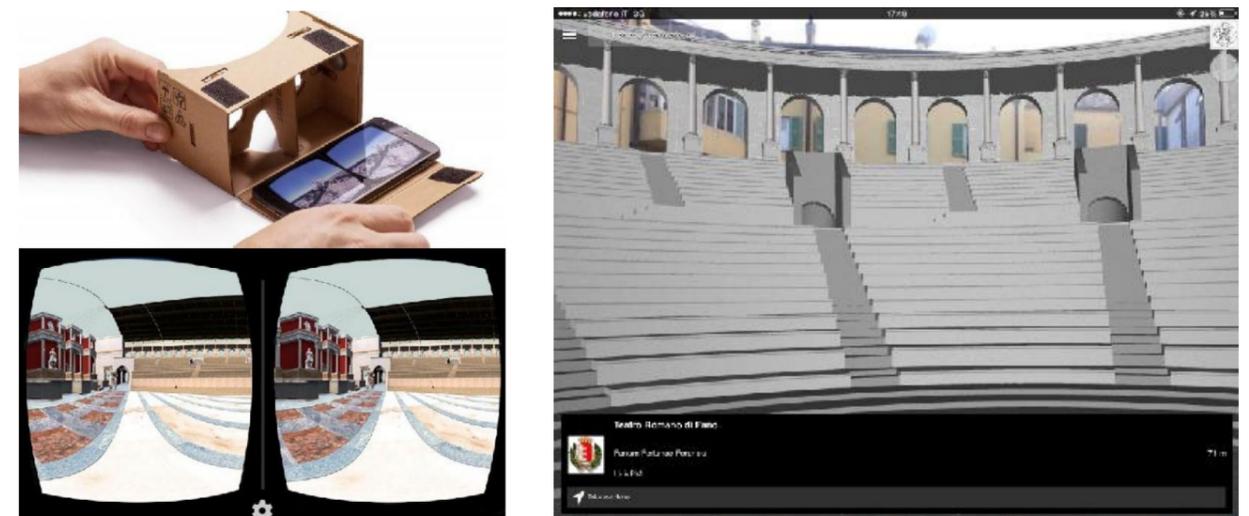


Illustration 12 and 13 an example of augmented reality on archeological site (Source: https://www.researchgate.net/publication/307530266_VIRTUAL_RECONSTRUCTION_OF_LOST_ARCHITECTURES_FROM_THE_TLS_SURVEY_TO_AR_VISUALIZATION)

2.3.3 THE CULTURAL AND ECONOMICAL IMPACTS OF USING VIRTUAL HERITAGE IN ARCHAEOLOGICAL SITES IN EGYPT

This paper discusses that the AR technology not only improves our knowledge of heritage sites but also to increaseses the attractiveness of heritage sites to visitors. It is also emphasized that the latter offers the ability to overcome restrictions on heritage sites, while also promoting the imortance and value of the adressed site, which in conclusion contributes to the common objective of preservation.

The digital reconstruction of heritage sites has received plenty of attention around the world in the past. The possibilities that could be achieved through that AR technology seem unlimited, even if there are some difficulties in rebuilding the past, because of the lack of complete historical data. Investigation and cooperation between archaeologists, art historians, architects, and planners is covered in this paper with the main objective being the data of the cultural and economic impact of using heritage technology in heritage sites.

One of the examples discussed is located within Tacitus, one of the field test areas of the Augmented Reality applications is a project called Reggia Venaria Reale's Palazzo di Diana. Within this project the architecture was modified several times over the years. Each change was documented through drawings. The drawings were overlaid on the current facade of the main building through a handheld device. The visitor observed the appearance of the building switched through the centuries, while seamlessly integrating into the environment., while listening to the story about the Palazzo through an audio guide. Finally, the whole scene looked like a real-time ancient drawing. This application worked as a virtual tour guide, involving the user into the story in a better way.

In conclusion, implementing virtual heritage technology in archaeological sites has a positive impact on attracting visitors, increasing the number of tourists and promoting archaeological sites. It is also emphasized AR technology at archeological sites ensures the preservation of the cultural heritage. It is considered as a process of re-documenting architectural monuments of archeological sites. (Farid, Ezzat, 2018)



Illustration 14 and **15** an example of Augmented reality on archeological site (Source: https://www.researchgate.net/publication/325049910_The_Cultural_And_Economical_Impacts_Of_Using_Virtual_Heritage_In_Archaeological_Sites_In_Egypt)

2.3 THE OPPORTUNITIES OF AR

The idea of applying AR in archeological sites is rather new, but it is tested and already regarded as a very useful tool for archologists, historians and visitors – everyone can have benefits. The possibilities that AR application provides are following:

- historical layer(s) of information can be reconstructed and used as an educational tool in the treatment of the archaeological heritage;
- reconstruction of dilapidated buildings or significantly altered;
- recreation archaeological missing or damaged parts;
- analyze an archeological object in its original environment;
- acts as an expansion of our own reality;
- simulation of social or natural environments on archaeological sites; (Prieto, Castaño-
- 3D scanning procedure is also useful to create a database, for cataloging reasons, for tourism promotion aims, for comparison studies, etc. Also the information is available indefinitely; (Prieto, Castaño-Perea, Arrayo, 2017)
- restoration and/or reconstruction time can be reduced;
- the costs for restoration and/or reconstruction can be reduced: manpower and machinery are utilized only at the real final step, so even the energy consumption is saved;
- some potential breakages or risk of destruction of the archeological, often fragile but valuable, artifacts to be restored and/or reconstructed can be avoided;
- some potential abrasions/changes in colors of the artifacts can be avoided;
- it is possible to establish forms and dimensions of the parts which are eventually incomplete so to rebuilt the artifact in an exact manner;
- it is possible to assemble the artifacts without damage its remains and even cause damages in the excavation site where the artifact was found;
- it is possible to preview the possibilities of assembling more easily, reducing errors and the time spent in those tasks; (Saggio, 2011)
- New, additional entertainment/artistic layers can be applied to provide new experiences. Raises the interest to the object;

2.4 CONCLUSION

Castle ruins, as archeological sites, hold important historical information and it has been explained how one should handle such artifacts since the 19th century. It is evident that the Western world's current approach represents the attitude that was described by Ruskin. Generally, over the course of ruins lifespan, theres an attempt to maintain them in their original state with as little intervention as possible. To preserve objects authenticity, the latter is done with caution and respect. The purpose of this project is to figure out how to apply AR to derive more meaning out of less preserved archoeological sites while they remain to be to commemorate the rich heritage

and history they offer. The concept that resolves mentioned matter is provided by the author of this master's thesis in the context of a two phased plan, which is based on the information presented in the previous chapters.

2.4.1 PHASE I – AR

In this phase the archeological site or object is reconstructed digitally in its former shape and then made possible to experience it with an application that uses a camera on a smart device. The AR application has a number of benefits, such as:

- Visitor can experience the former shape of an historical object
- Information is archived
- Information can be used for educational means
- Since AR is applied, new entertainment AR layers can be also implemented
- Raises overall interest to an historical object

In order to provide working AR application, the 3d model of existing physical material would be made, thus the historical 3d material is archived. It is worth noting that despite the existence of Estonian and international guidelines for the preservation of archeological sites, the AR application can be extended to any archeological site regardless, because the ruins are not externally disturbed as they are not physically interfered with. The existence of the object over the course of its lifetime remains the same as it has been since the preserving approach toward such objects was introduced.

Digital reconstruction is flexible and has unlimited possibilities, thus it could be used to present all four preservation approaches that were described in chapter 2.1.3. Because of the high

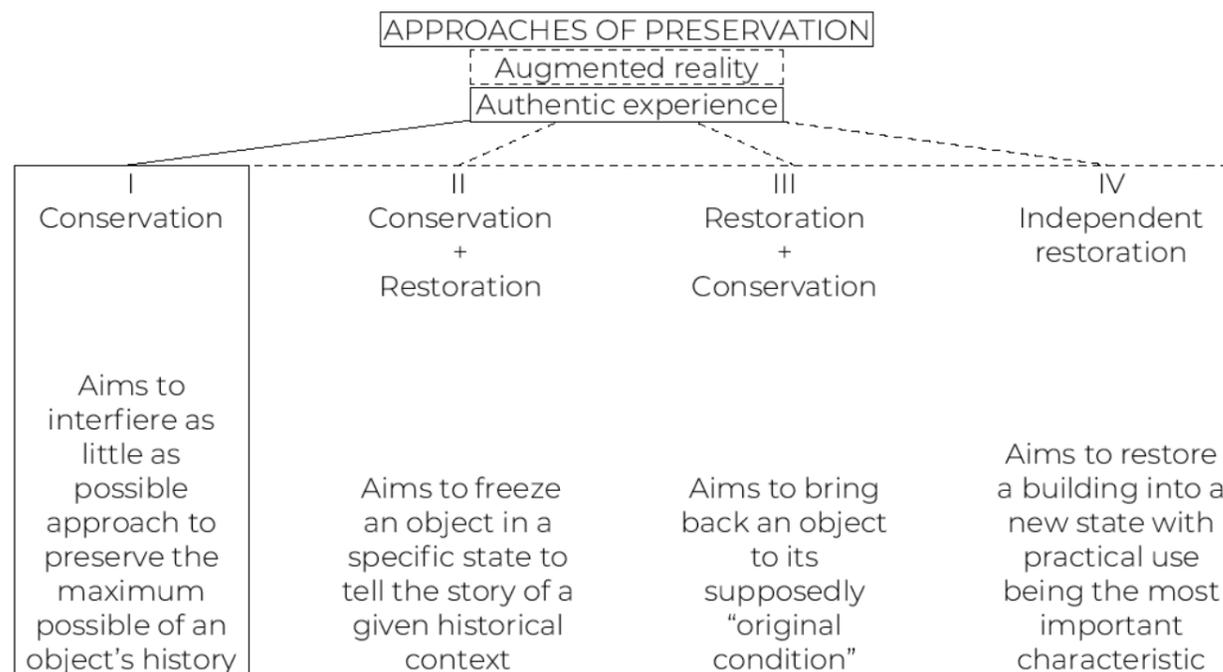


Illustration 16 Augmented reality as the extension of approaches of preservation (by author)

number of benefits and low resource requirements its is reasonable to apply AR to archeological sites.

2.4.2 PHASE II – IMMERSIVE AR

The existence of AR opens up new possibilities for perceiving a historical object in its former space. The innovative part of this project is the idea of providing a better AR experience to the visitor of the archeological site. It could be one by having a location near the object where visitors can rent AR glasses and also by designing and building a structure, such as a walkway that provides an access for the visitor to experience spaces and views that historically people would experience when the castle was used. These previously mentioned two ideas provide the visitor the opportunity to experience AR in a more immersive way. In the latter case, it should be borne in mind that, in order to respect the object in question, the ruins of an archeological site, the structure of the walkway has to have following characteristics:

- parted from the historical object:
 - the original structure cannot be damaged;
- temporary:
 - when needed, it can be removed;
- flexible:
 - when needed, it can be changed;
- transparent and light weight:
 - to have contrast and not to overpower original volume;
- designed according to location-specific characteristics, especially history;
 - if the volume of the walkway follows the historical information, then former shape of the object could be resembled.

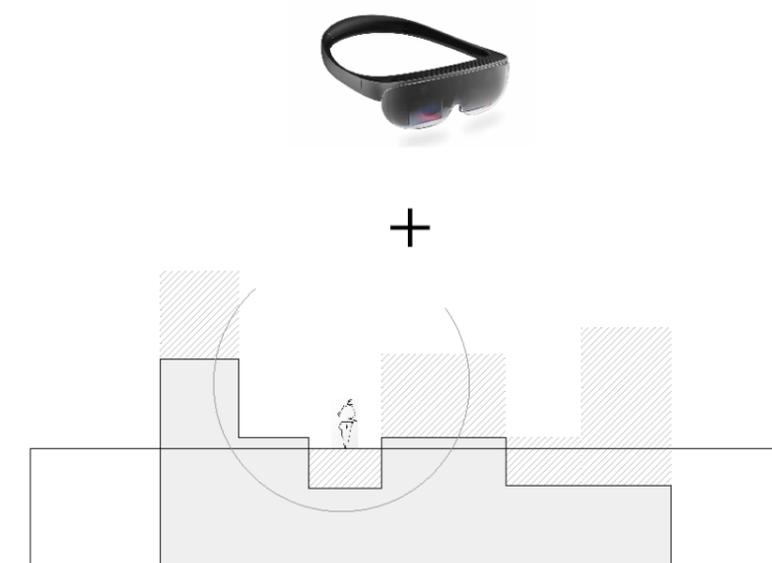


Illustration 17 The concept of Phase II – Immersive AR (by author)

3. TOOLSE CASTLE

Toolse Castle is an archeological site on the northern coast of Estonia. Toolse castle is appropriate for addressing the problem raised in this Master's thesis. Currently, in contrast to the castles in Narva and Rakvere, Toolse castle is by its nature a rather neglected site due to its location, lack of facilities and fact that most of the original volume is in ruins. On the other hand, despite previously mentioned factors, it is nevertheless beautiful and has plenty of potential for experience.



Illustration 18 The ruins of Toolse castle (Source: <https://www.visitestonia.com/en/toolse-order-castle>)

3.1 SITE ANALYSIS

As mentioned in the introduction to this chapter Toolse Castle is located in Estonia, on the northern coast of Lääne-Virumaa, in Kunda Bay, which is located above the town of Kunda, also Rakvere is 30 km further down south. The capital city of Estonia Tallinn in the west and Narva in the east are both ~ 110 km away. The Toolse Castle is mostly accessible to tourists along the highway that connects the two. Nearby accommodations are highlighted on the illustration 19.

The Toolse fortress is situated on the Toolse peninsula. A parking lot is located approximately 400 meters south of the ruins, from which a footpath leads to the site. The ruins are on the highest level of the peninsula's subtle relief. The ground is sandy, the vegetation is low, with some larger bushes and the object is surrounded by stones and boulders in different sizes. From Toolse Castle, there are magnificent and valuable views to every cardinal direction. This makes sense since castles are usually built in a location where the maximum amount of territory can be controlled.

The only source of shade is provided by the ruins and the sun rises in from the east, shines from the south, and sets in the west. The fact that a person could observe the sunrise and sunset from the site is extremely valuable. The winds blow mainly from the north and northeast on average of 4,1 m/s (Kliimanormid, 2021).

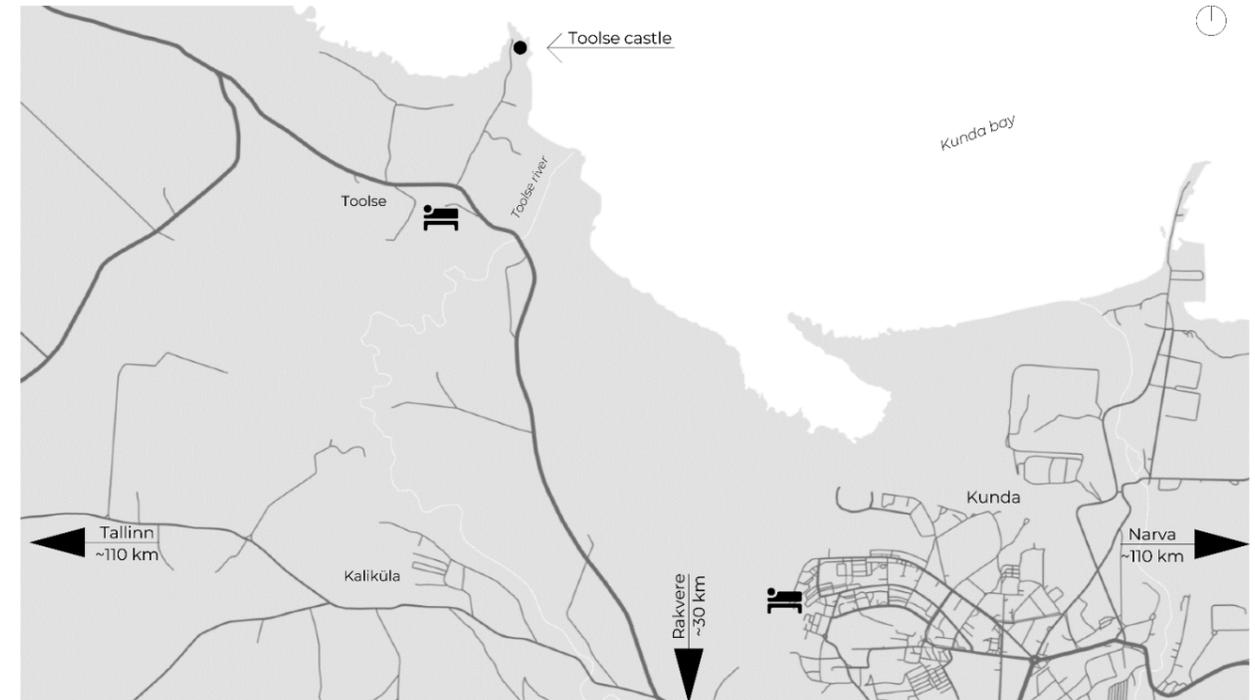


Illustration 19 Location diagram (by author)



Illustration 20 Existing site (by author)

3.2 HISTORY

There hasn't been done any systematic researches for the castle of Toolse (Muinsuskaitse Eritingimused Toolse Linnusevaremete Konserveerimiseks, 2004). The following summary of the history of the fortress does not appear to be exhaustive, but it does include as good overview of the object's history as possible based on available content that is provided by archives.

One person who has researched Toolse castle in a greater depth is K. Aluve, who has concluded that there are five significant building phases during the castle's formation. But, it has to be noted that K. Aluve's findings are likely not 100 percent accurate, as the Heritage Protection Agency's special conditions of heritage protection for Toolse Castle, published in December 2004 under the title "Toolse linnuse varemed", work number 2004-54, identify questionable points and unanswered problems in K. Aluve's study. However, some of the conflicts that were raised in the legal document were not resolved and it is stated that systematic research had never been conducted, thus it does not claim to the accuracy of the proposed insight. Therefore, this master's thesis is based off K. Aluve's data since it provides the most comprehensive collection of information about Toolse castle.

The existence of Toolse castle is linked to the nearby port, which was located near the confluence of the Toolse river and Kunda bay, which was once Virumaa's second most important harbour. Johann Wolthus von Herse, who was Liivimaa master of order at that time, founded the fortress in 1471. It used be called *Vredeborch* and after *Tolesborch*. Although some argue that the castle's main objective was to secure the harbor, others suggest that it was actually built to defend against Russian forces advancing from above *Narowwa* (Narva). Afterall, Johann Wolthus von Herse main goal was to strenghten the defence capabilities of Liivimaa against russian forces, because preventing eastern expansion was more important at the time than defending against local bandits. (Aluve, 1993)

3.2.1 THE LATEST FLOORPLAN OF TOOLSE CASTLE

In the late medieval period Toolse castle had a rather chaotic floor plan solution for a fortress in its final form. On the south side of the fortress, there are three rectangular towers (5,6 & 7), the gate tower being the easternmost. There are two courtyards (1 & 2) behind the south wall, between the towers. Buildings and rooms (10-13) within the castle used to be situated behind the north wall. The walls of room 11 are partially preserved and traces of a spacious chimney indicate that it used to be a kitchen. On the northwest corner was a large round tower for cannons (9), which at this time is demolished. A block of latrines servicing different floors is located next to the collapsed round tower in the fortress's north wall. On the east, there used to be a wide spacious front yard (3), which could be reached through the gate tower (4) and it also provides an access to the second courtyard (2). The second courtyard (2) has connections with rooms 12 and 13. The first courtyard (1), which has two rows of weapons shots at the bottom of the south wall and

rooms (7-11) on the northern side, can be reached through pedestrian gate on the west side of the castle and from the second courtyard (2). (see illustration 22) (Aluve, 1993).

3.2.2 CONSTRUCTION STAGES OF TOOLSE CASTLE

Fortress was built in at least five stages with limestone and mortar, occosionaly there are also some large, round irregularly shaped crystallised stones inbetween. The oldest part was built in the 15th century behind the west façade. It was an elongated 3-storey building with a tower on the south side. The castle with measures of 7x20 m was meant for living. The building could be accessed through a gate in the west wall.

In the second stage of construction the castle was extended to the east. The front yard was built to the east and court yard to the middle of the castle. Both spaces had rooms that were used for living in the north. Also, along to the south wall there was a gallery that had a purpose of defending the northern flank.

In the third stage of construction the gate tower was built in the southeast corner of the castle.

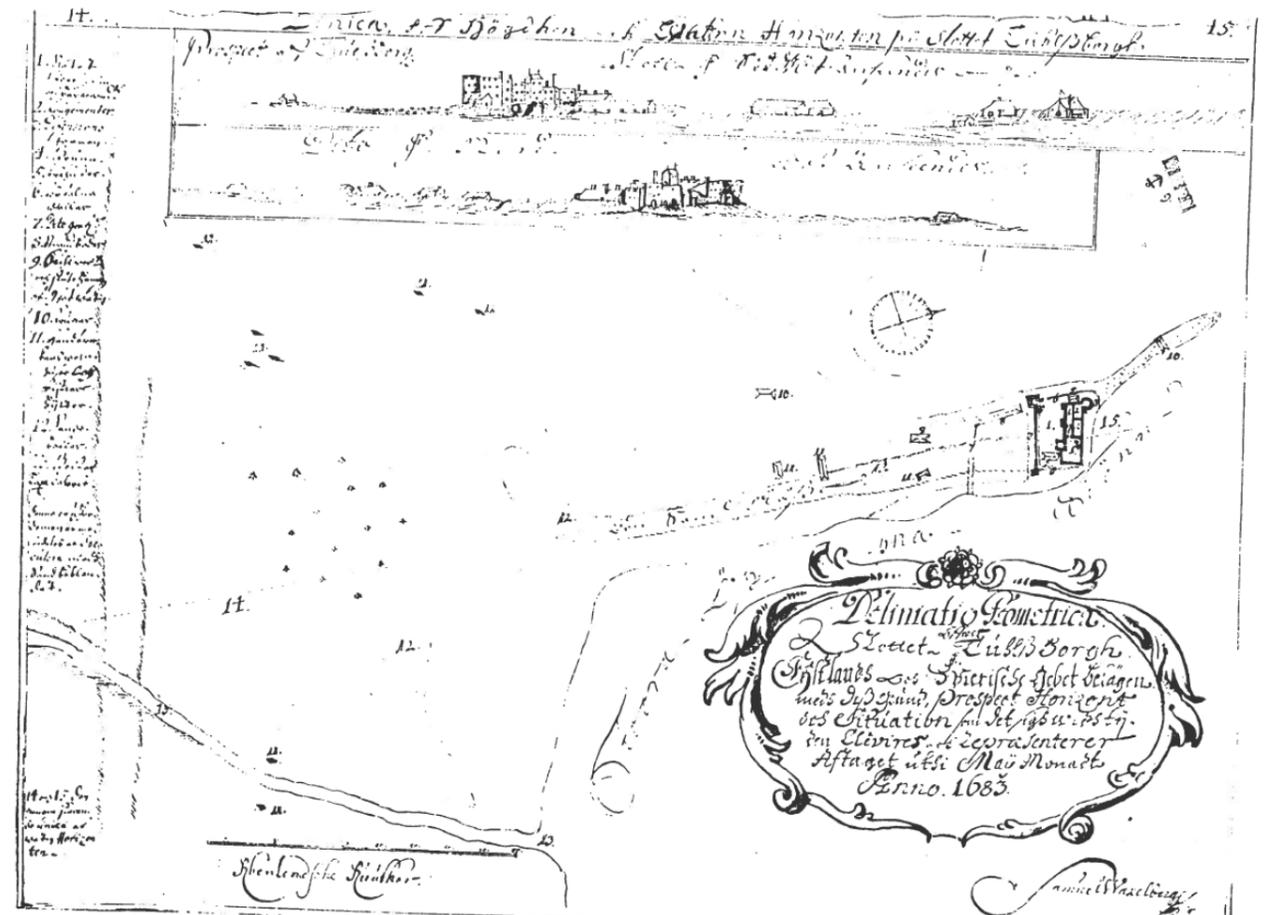


Illustration 21 The historical elevations and site (Source: Muinsuskaitse Eritingimused Toolse Linnusevaremete Konserveerimiseks, 2004)

In the fourth stage, a big round cannon tower was built in the northwest corner of the castle. People used to have an access on the roof, which was surrounded by a wall that had jagged extrusions for the soldiers to take cover from attacks.

In the final stage of construction another frontyard was built on the east side of the castle. A gallery was also added along the surrounding walls. (Aluve, 1993)

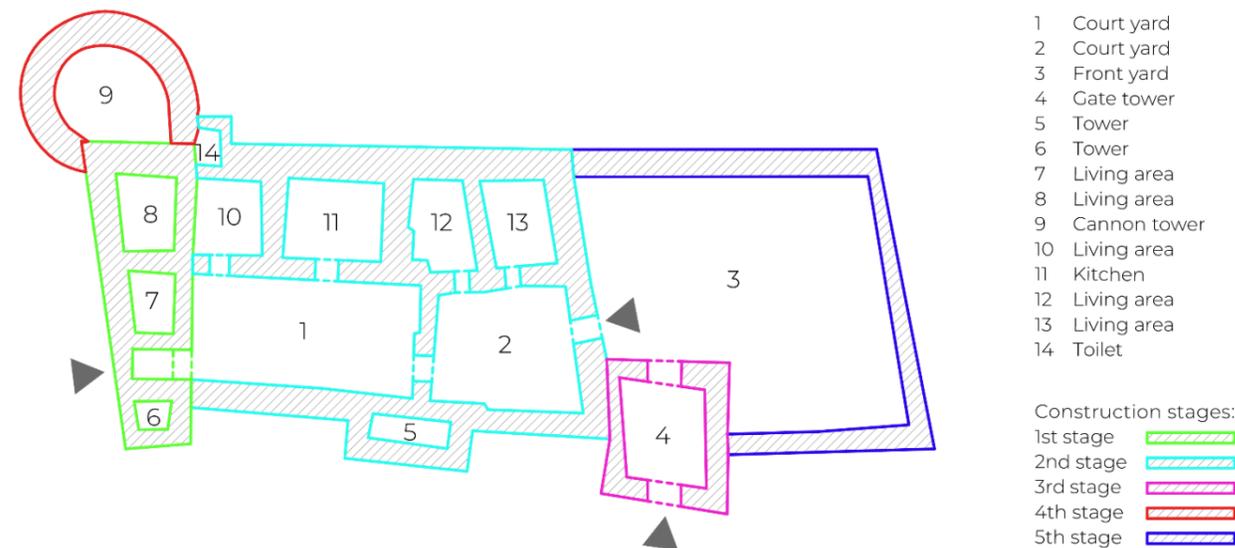


Illustration 22 The latest floor plan with construction stages of Toole castle based on K. Aluve's (1993) drawings (by author)

3.2.3 LIST OF IMPORTANT EVENTS

- 1558 - after the capitulation of Narva, Porkuni, and Rakvere, bailiff Hinrich von Gallenbach prefers to flee, and Toole castle falls to Russian forces without resistance in August of the same year. Hijackers from Tallinn retake the fortress in the same month, but Russian cannons compel them to flee soon after.
- 1574 - the Swedes attempted to seize the fortress, but were unsuccessful and lost a few men in the process.
- 1581 - the Swedes under Pontus de la Gardie conquered the Toole castle.
- 1600 - the castle is conquered by Polish troops.
- 1605 - Toole is retaken by the Swedes, who fortified the castle over the next few years.
- 1617 - Toole castle was granted to Wrangels during the feudalization period.
- 1685 - Toole castle was reclaimed by Sweden.

The castle is said to have been in ruins since the Great Northern War, and at the turn of the nineteenth century, it was in roughly the same state as it is today. (Muinsuskaitse Eritingimused Toole Linnusevaremete Konserveerimiseks, 2004)

3.3 HISTORY OF CONSERVATION

The first documented inspection of Toole Castle was carried out in 1964. Numerous inspections, reviews, small-scale audits, cleaning and support work have been completed since then. In 1992, the first known fortification project was done. The first conservation building project was made in 2004, with work beginning in 2006 and continuing to this day. A total of € 78,973 has been requested for conservation of the castle since 2005. The course of conservation over time is shown on illustration 23. (15951 Toole linnuse varemed, 2021) (see extra 1.)

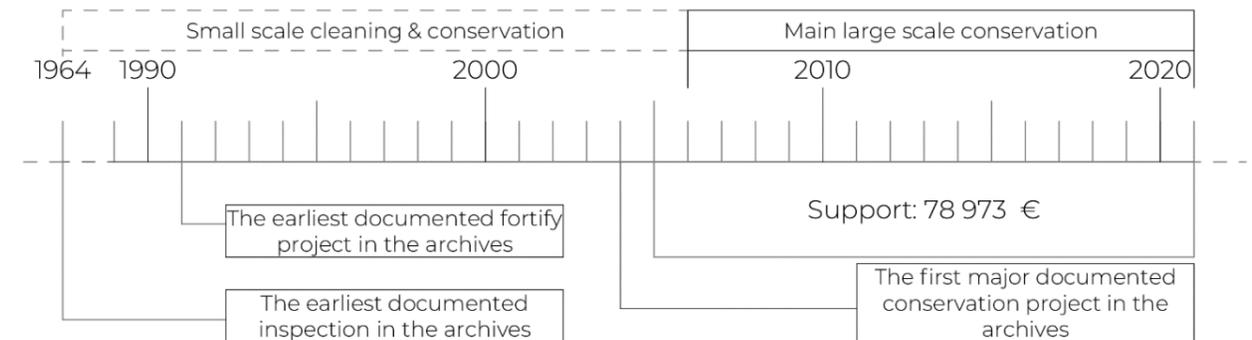


Illustration 23 The history of conservation of Toole castle (by author)

The Toole castle has been conserved in a humble and polite manner, with using traditional building methods and materials. Fresh, non-original interventions can be distinguished from the historical layer by being lighter in color, which is one of the conservation principles of the Western world - it is important that the historical and new layers provide a distinction that helps the viewer to differentiate the old from the new. Furthermore, hawsers and anchors are used to reinforce the walls in some areas of the castle. (15951 Toole linnuse varemed, 2021) (see illustration 24 and 25)



Illustration 24 and **25** The conservation of Toole castle (Source: <https://register.muinas.ee/public.php?menuID=monument&action=emergencysupport&id=15951>)

4. ARCHITECTURAL SOLUTION

The following architectural solution is based on the theoretical discussion in Chapter 2 and the object analysis in Chapter 3 done in this master's thesis. According to the conclusion of Chapter 2.4, the concept is divided into two phases, while also taking into account the instructions provided.

4.1 FIRST PHASE – AR

The goal of the first phase is to provide an AR application that works on a smart device that can be used to experience the castle's former shape. To achieve this, firstly one must first create a 3d model of the castle ruins, then reconstruct the former volume by digitally modeling it on top.

4.1.1 PHOTOGRAMMETRY

Photogrammetry was selected as the technology for creating the 3d model in this master's thesis, which is technology of obtaining reliable information about physical objects and the environment through the process of recording, measuring and interpreting photographic images and patterns. The reasoning behind the selection is that it is relatively inexpensive, produces a model with sufficient precision, and the produced model is a mesh with surfaces with excellent interoperability between different 3d softwares. Also, the surfaces have textures that are very similar to the real ruins, which can come in handy later when the design of the digitally reconstructed model is being made. The photogrammetry of Toolse castle was done with a DJI Phantom Pro v2 drone and Dronedeploy software.



Illustration 26 Author flying the DJI Phantom Pro V2 drone for photogrammetry by Author's friend

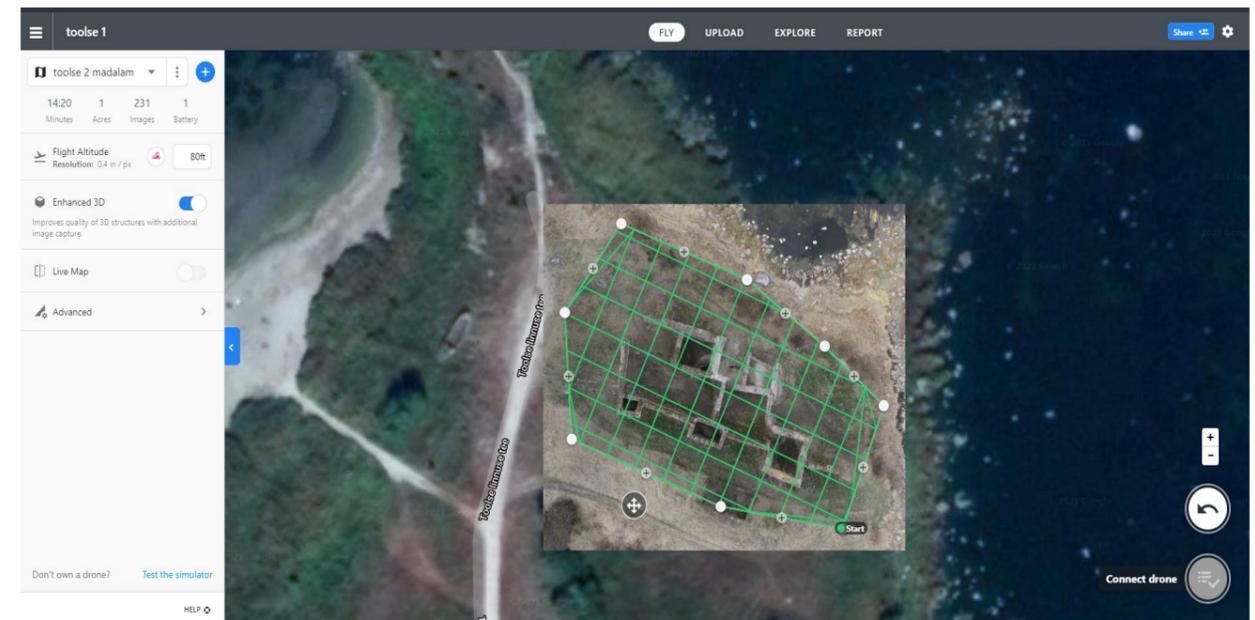


Illustration 27 The dronedeploy software (Source: <https://www.dronedeploy.com/>)



Illustration 28 The model of the Toolse castle done with photogrammetry with dronedeploy software (by author)

4.1.2 DIGITAL RECONSTRUCTION OF FORMER VOLUME

Since there is little information about the former shape of the castle, the rebuilding of the castle is rather speculative. The volume was reconstructed as much as possible according to the illustrations and literature provided by Cultural Heritage Protection Agency's archives. The former volume was restored using Archicad 24 Education version software.

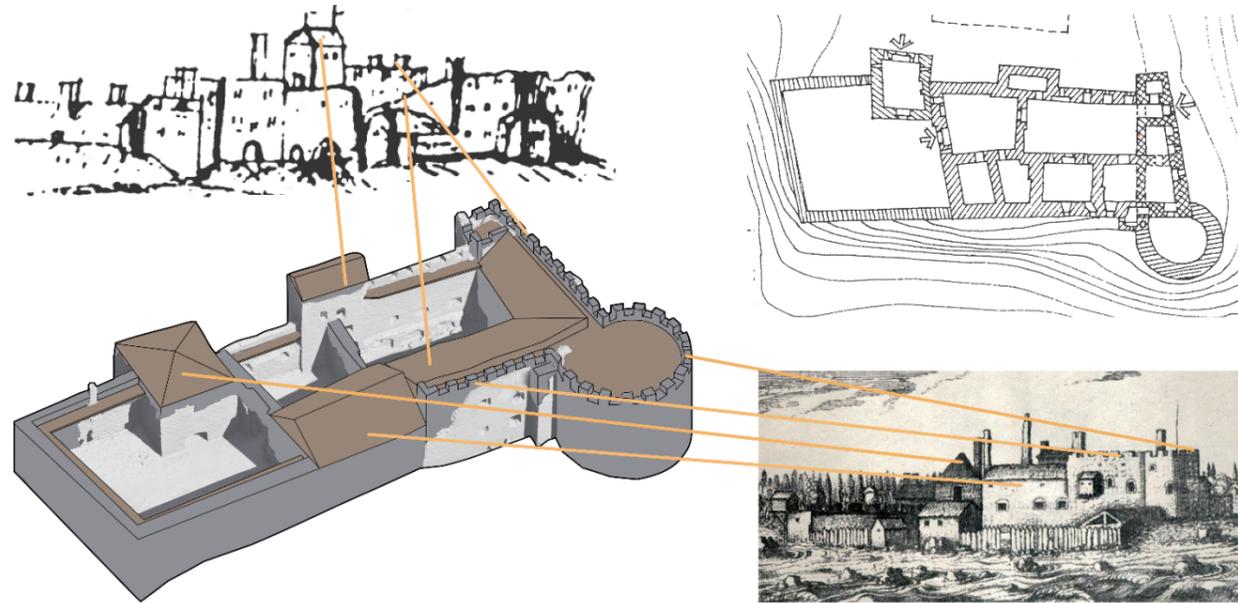


Illustration 29 The 3D reconstruction diagram (by author)

4.1.3 AR EXPERIENCE

Within this master's thesis the AR experience is visualized with illustrative material, where the digital layer is added to the footage made on site by computer generated imagery (CGI). Blender is the software that was used to create the CGI. It was necessary to preserve the contrast between the modern and the old, so that the restored digital layer would match but be easily distinguishable from the original one. The purpose of this illustrative material is to demonstrate the volume and level of detail of the digital layer that could be experienced with a smart device in the context of next few years of technological development. The footage can be accessed via QR code or link:

<https://www.youtube.com/watch?v=ZHMzr1Y3V2E>



Illustration 30 Footage from site (by author)



Illustration 31 The reconstructed AR layer of Toole castle. Added on footage with CGI in order to illustrate the AR experience possible in a few years (by author)

4.2 II PHASE – IMMERSIVE AR

The purpose of second phase is to make the AR experience more immersive. The theoretical discussion of this master's thesis concluded that this could be achieved if the visitor could observe the digital layer with using rentable AR glasses on a walkaway. This solution opens up the former spaces and views that people used to experience when using the Toelse castle. Interference of these elements will only be successful if it is done in a humble and respectful manner, since the historical content is very valuable and must remain untouched.

4.2.1 THE WALKAWAY

The walkaway is designed based on the characteristics concluded in Chapter 2.4.2:

- Temporary
- Easily disassemblable
- Separated from the historical construction
- Transparent/light weight
- Designed according to location-specific characteristics

It consists of 700x700 mm square shaped modules that are built with 35 mm square cross-section stainless steel posts and beams with wired mesh between them. Using this module, different larger modules are welded

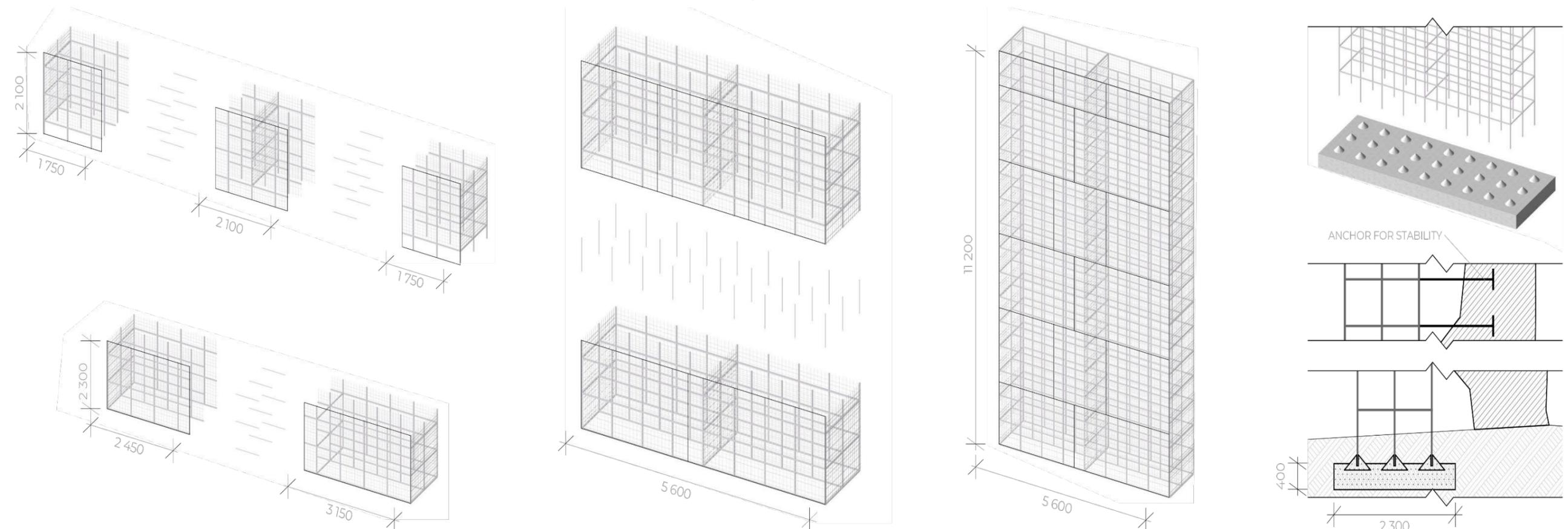
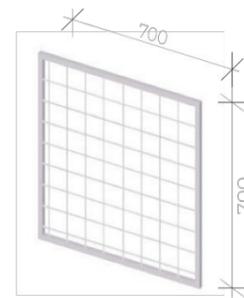


Illustration 32 The modular construction system of the walkaway (by author)

together. On the side of the bigger modules, the welded posts and beams have female openings. The larger modules are attached with using steel sticks that operate as the male side of the connection. The structure is supported by a heavy concrete foundation with the posts inserted into cone-shaped footings, and the structure is secured into the old wall in instances where extra stability is required.

The linear walkway is designed in accordance with the fortress's historical volume. It is accessible to visitors by walking through the easternmost tower, which was once the gate tower. Then across the space previously known as the front yard to the castle's north-eastern corner, where the first staircase leads to the underground room and the second to the walkaway. Downstairs, one can rent AR glasses and relax in a safe space with a view to the north. From the northeast corner of the castle, the walkway proceeds to the south, then to the west, over the gate tower. From there it continues parallel the southern wall, along the former gallery that was used to defend the southern flank, to the southwest corner, on top of the part of the castle that was used for living. The walkway continues to the platform on the northwest corner, which is situated on the location of the former destroyed cannon tower, from which the spiral staircase leads down to the ground. The modular construction system of the walkaway is demonstrated with illustration 32. The pavillion is constructed with concrete and rammed earth.

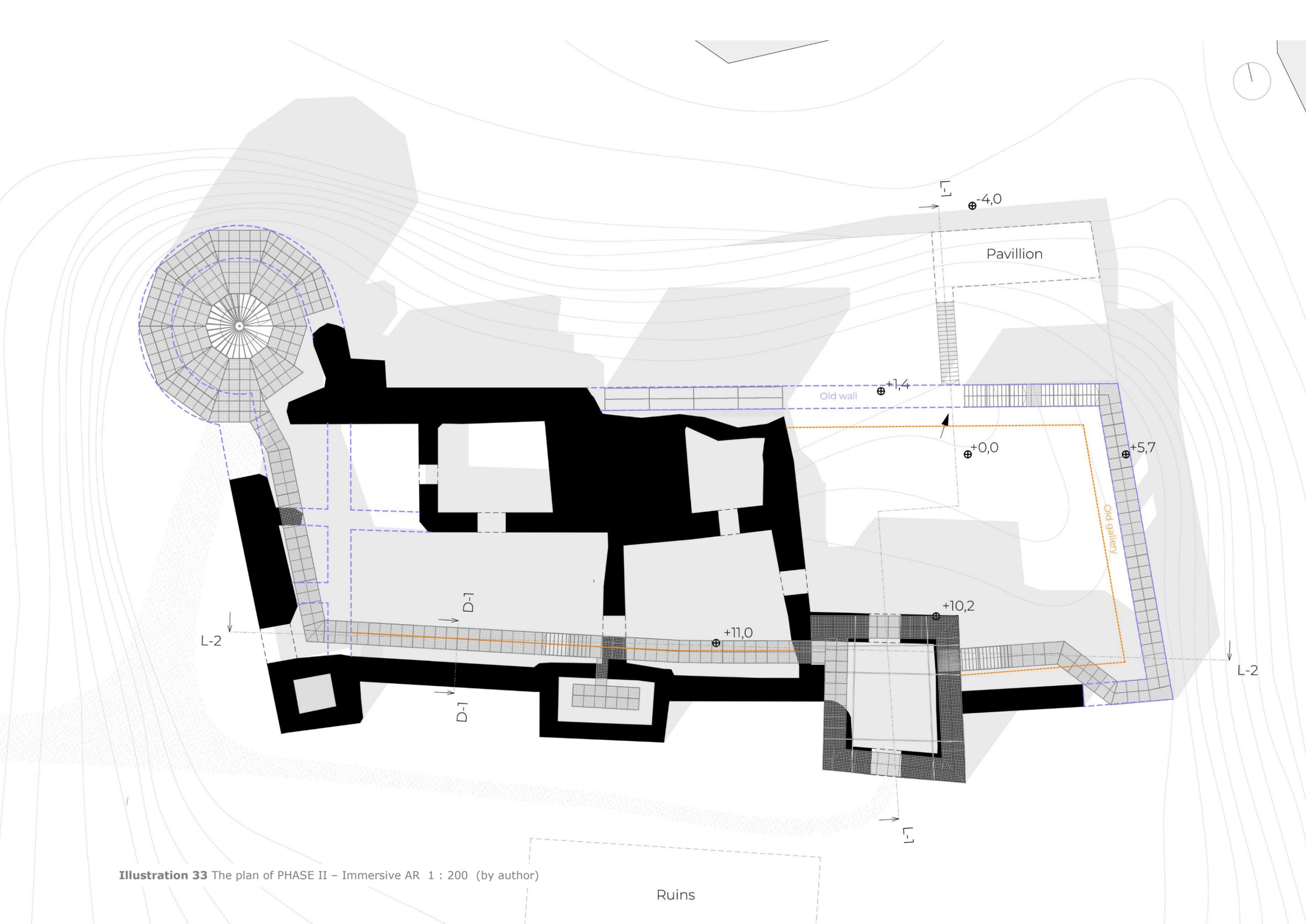


Illustration 33 The plan of PHASE II – Immersive AR 1 : 200 (by author)

Ruins



Illustration 34 The trajectory of the walkaway (by author)



Illustration 36 The birdview of the project (by author)



Illustration 35 The view from to the east on the walkaway (by author)

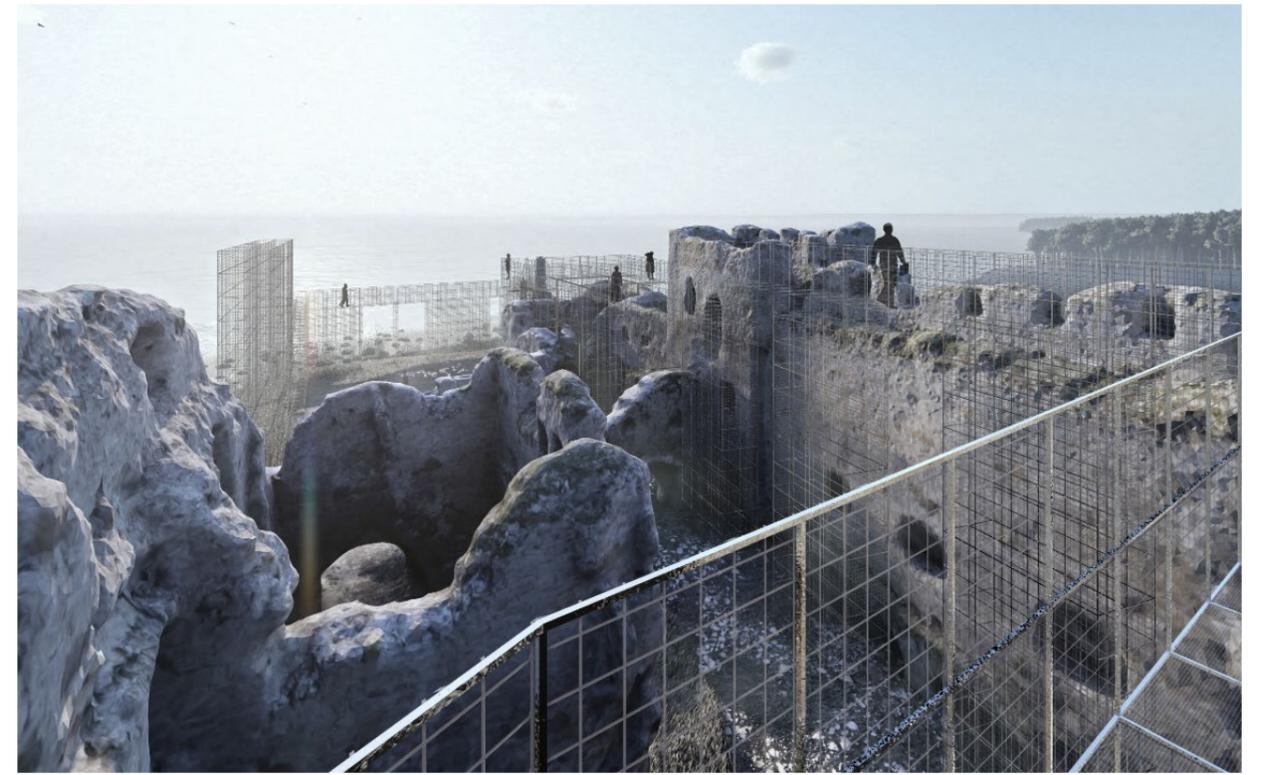


Illustration 37 The view from to the west on the walkaway (by author)

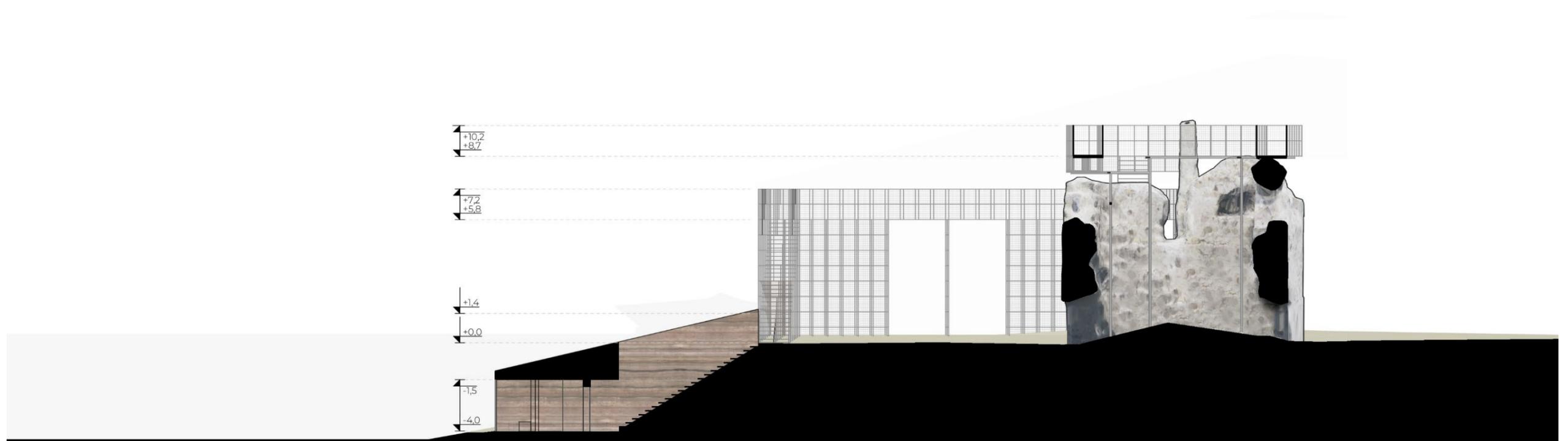


Illustration 38 Section L-1 (by author)

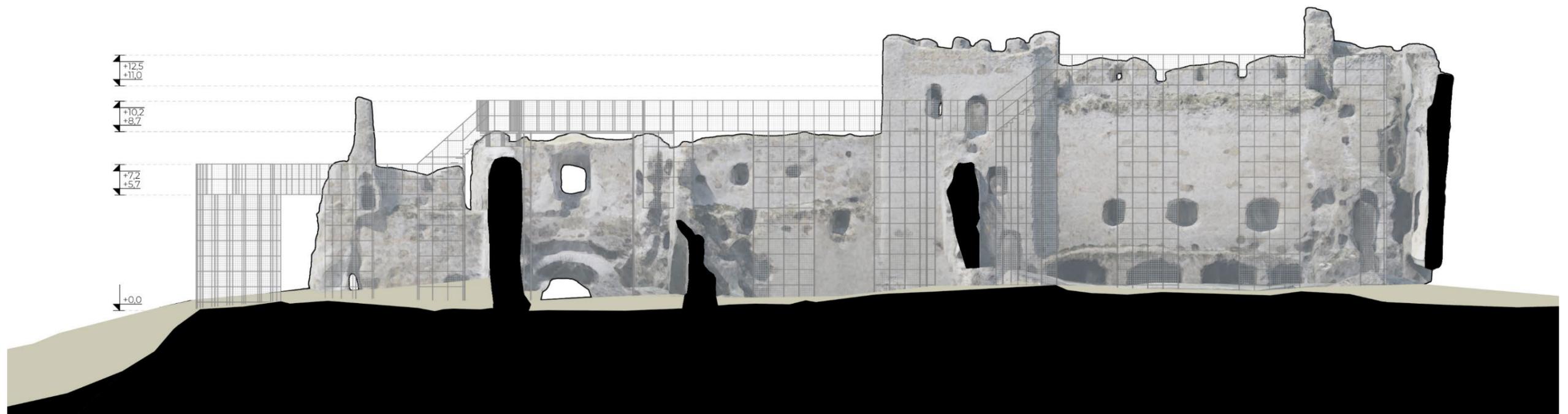


Illustration 39 Section L-2 (by author)

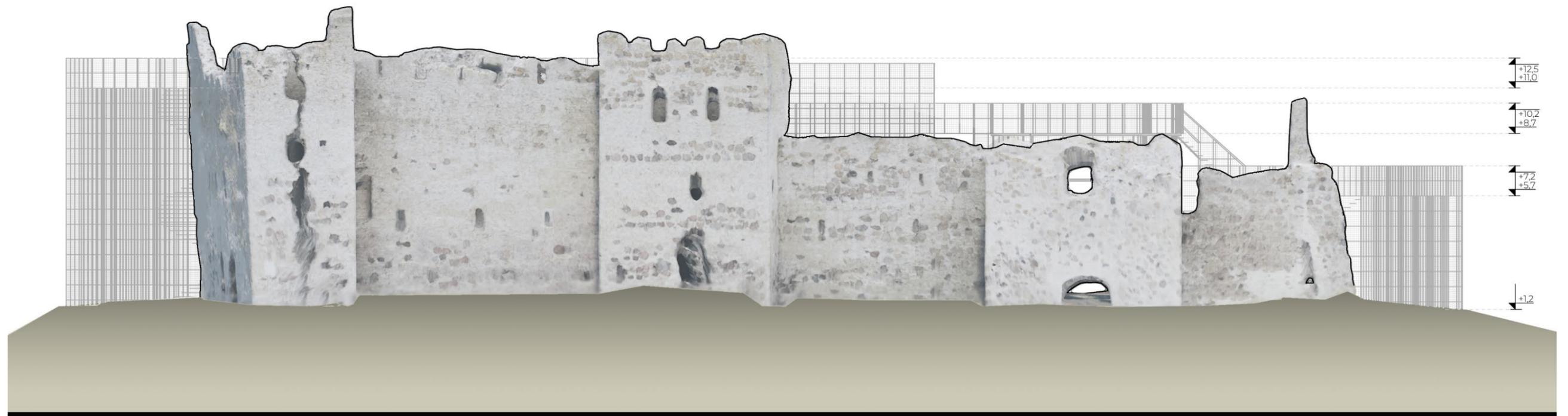


Illustration 40 Elevation from the south (by author)

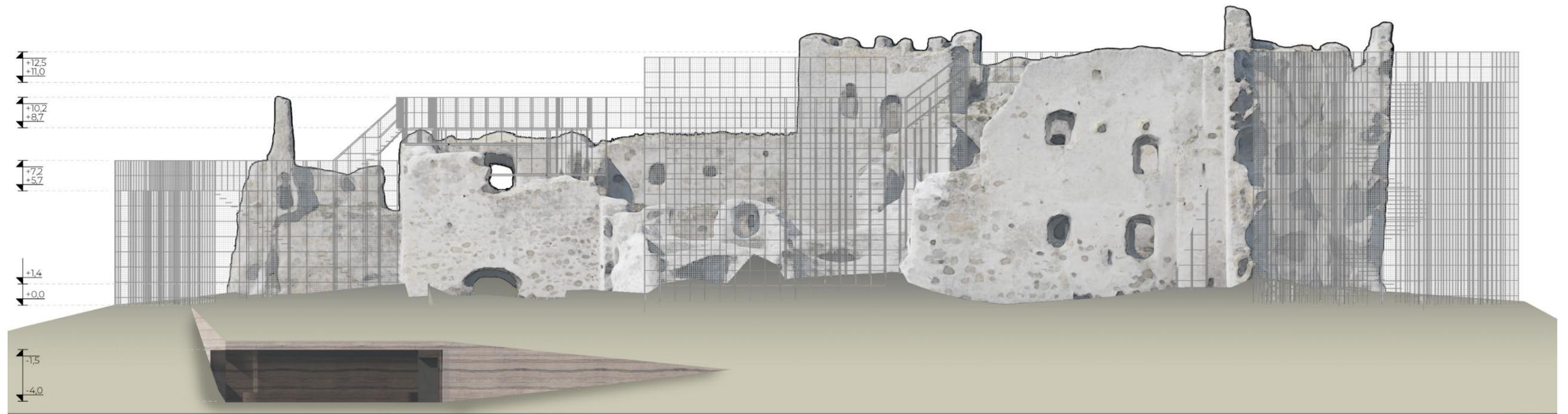


Illustration 41 Elevation from the north (by author)

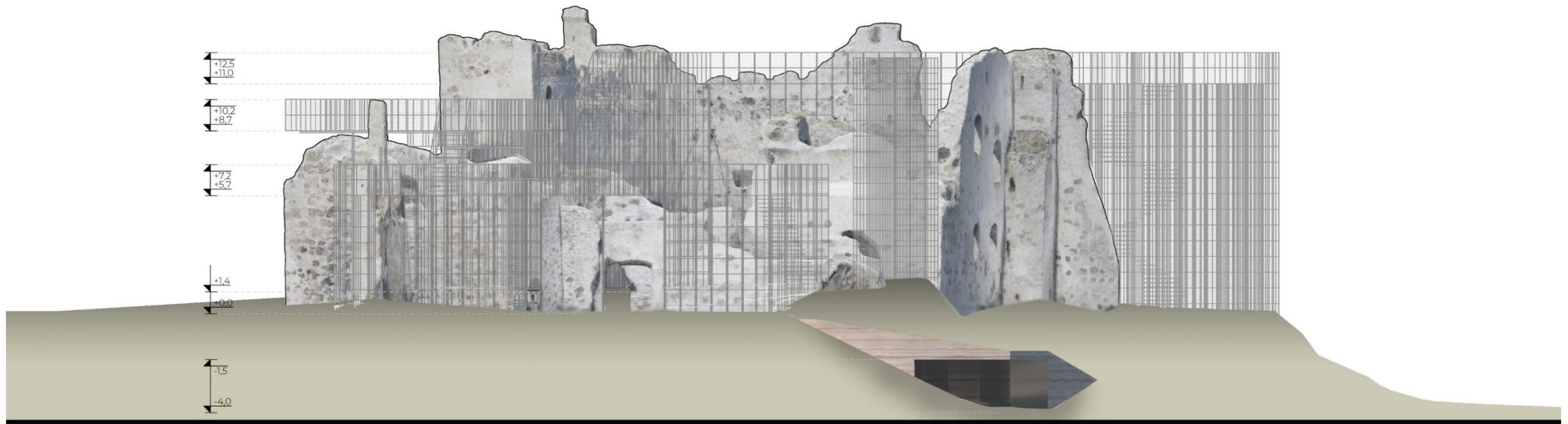


Illustration 42 Elevation from the east (by author)

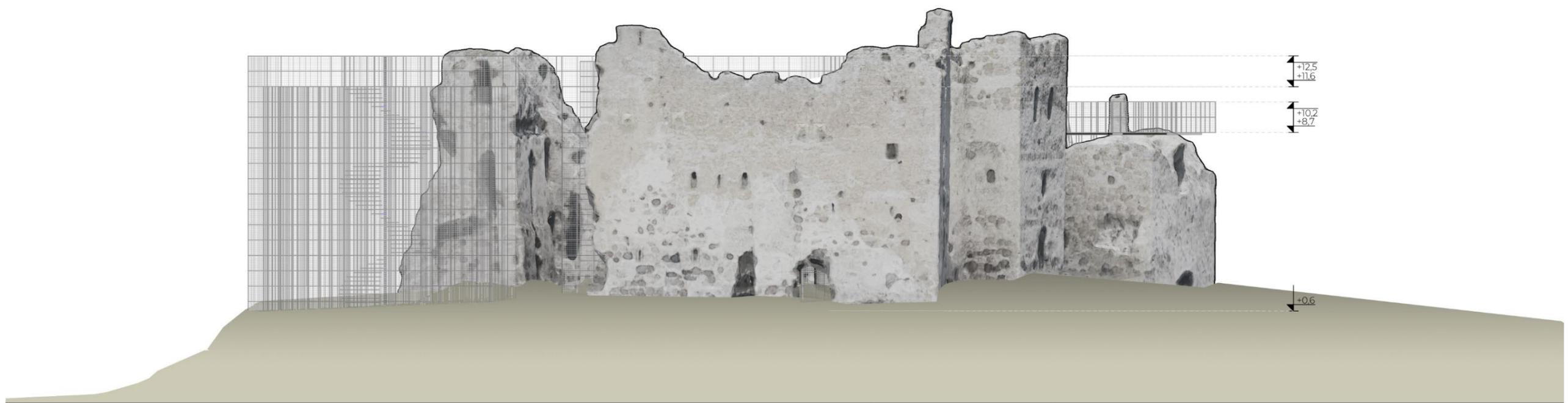


Illustration 43 Elevation from the west (by author)



Illustration 44 The view from the north (by author)



Illustration 45 The view from the south-east (by author)

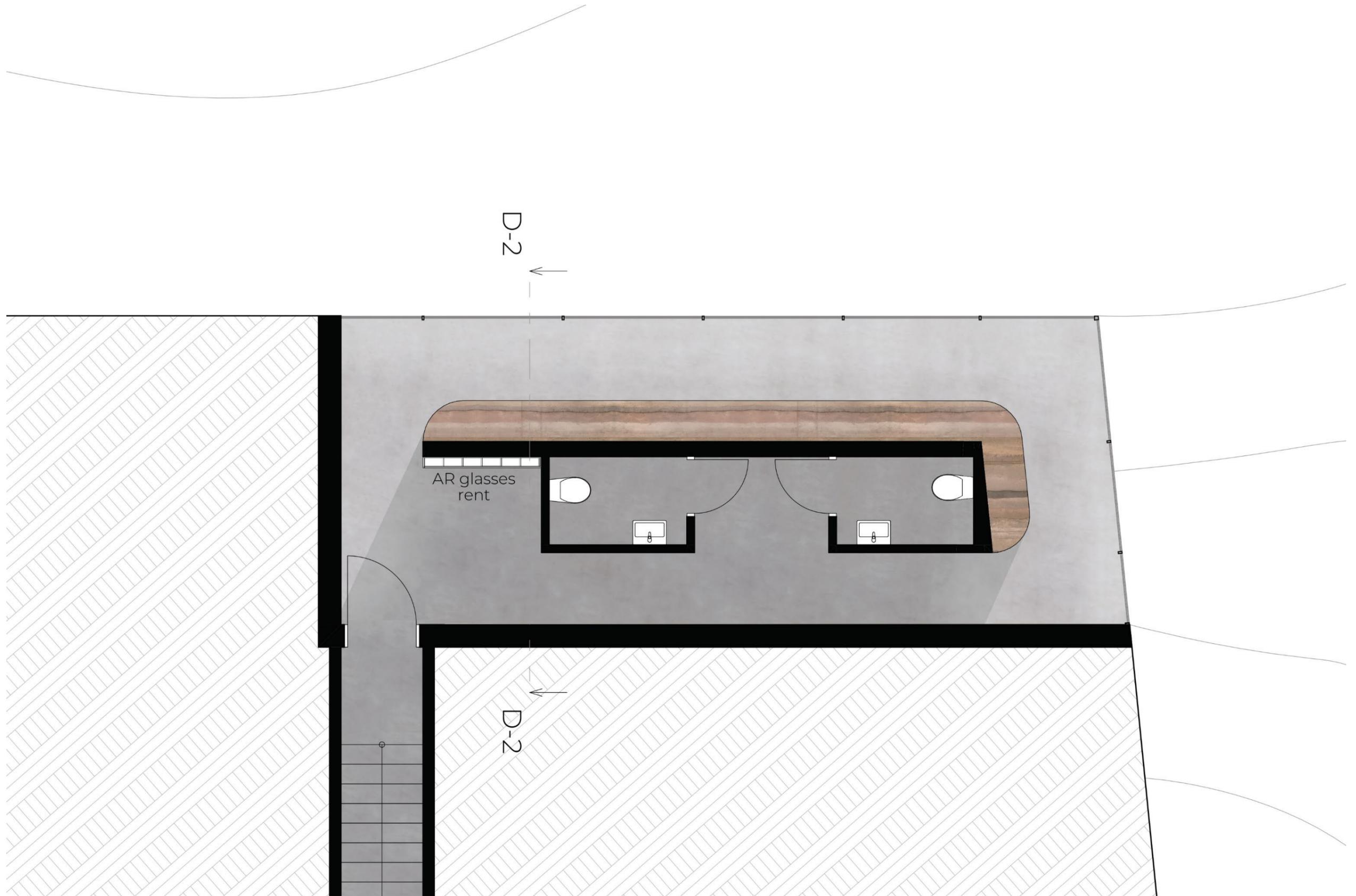


Illustration 46 The plan of the pavillion (by author)

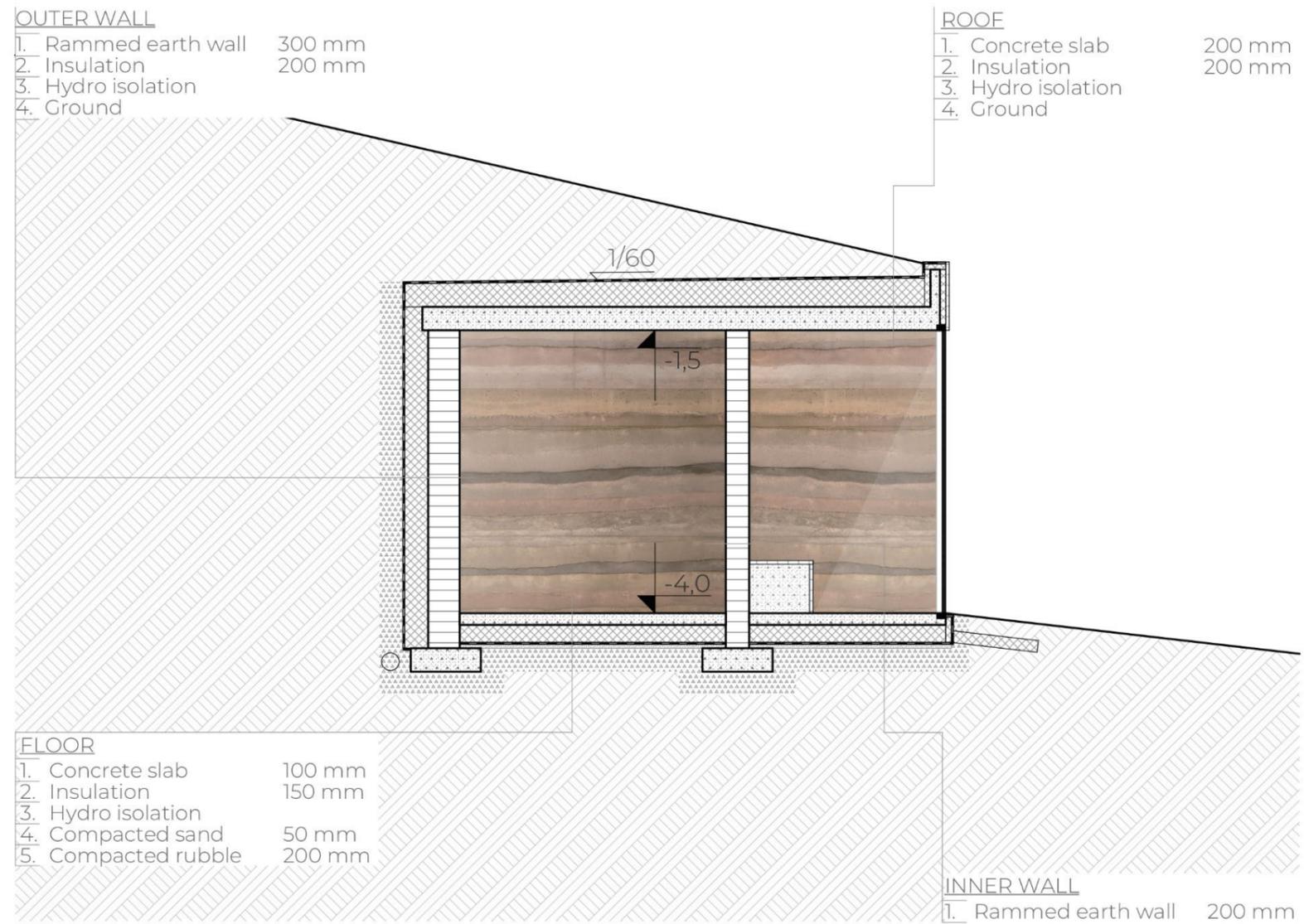


Illustration 47 The section D-2 of the pavillion (by author)



Illustration 48 The interior of the pavillion (by author)



Illustration 49 The view from the north (by author)

Furthermore, the harmony between the walkaway and AR layer is explained using the following illustrative content. Blender software was used to create the CGI on top of the footage that was taken on site. https://www.youtube.com/watch?v=5_oeqS18b5I



Illustration 50 The reconstructed AR layer of Toole castle with walkaway. Added on footage with CGI in order to illustrate the AR experience possible in a few years with the walkaway (by author)

CONCLUSION

This master's thesis sought the means to apply AR to less preserved archaeological sites to derive more meaning out of less preserved archaeological sites while they remain to be to commemorate the rich heritage and history they offer.

The thesis begins with the first chapter of the theoretical discussion, which explains the approach to preservation of archaeological sites in western culture by examining its origin and guidelines. In the second chapter reference projects are used to explain the nature, implementation, and opportunities of AR.

The discussion concludes with a summary that explains how to apply the AR to archaeological sites in a two phase approach. In the first phase it is discussed that it is reasonable to apply AR to an archaeological site because it supports the common objective of preservation of archaeological sites and it has a number of positives at a relatively low cost.

The innovative aspect of this master's thesis is the second phase of the concept, in which the visitor is given the chance to explore the digital layer in a more immersive manner. This is accomplished in two ways: first, by providing access to AR glasses on-site, and second, by walking along a walkway built according to location-specific characteristics (particularly historical data), that enables visitors to experience the space and views that the castle's users once did.

Following the theoretical discussion, a case study of the Toolse castle's is done, which includes analysis of location, history and conservation. The object was selected as an example for the design part of this master's thesis.

The master's thesis ends with a solution that is based on the case study and the summary of the theoretical part, due to which the concept is divided into two phases. In the beginning of first phase the photogrammetry study is performed by the author, then the speculative reconstruction of the former volume of the castle are presented. The phase ends with a visualization, the purpose of which is to demonstrate the AR experience and the volume that can be observed on site by visitors in the coming years, considering the pace of technical advancement.

The second phase is the innovative part of this master's thesis, which introduces a walkaway that is designed according to the set of characteristics defined in the conclusion of the theoretical part, with the aim of being humble and respectful towards Toolse castle's historical layer.

In order to achieve the purpose of this master's thesis, a proposal was made on the example of Toolse castle, in which the concept was divided into two phases. The thesis taught the author a lot about the restoration and conservation archaeological sites, as well as the possibilities and advancements in AR technology.

KOKKUVÕTE

Magistritöös otsiti võimalust, kuidas rakendada AR tehnoloogiat vähem säilinud arheoloogiamälestistele eesmärgiga ammutada neist rohkem tähendust, et mälestada nende rikkalikku pärandit ja ajalugu.

Uurimust alustatakse teoreetilise osa esimese peatükiga, kus selgitatakse, milline on ja kust pärineb lääne kultuuriruumi lähenemine arheoloogiamälestiste konserveerimise ja säilitamise suhtes. Teooria osa teine pool selgitab AR-i olemust, rakendust ja sellega kaasnevaid võimalusi analüüsid referentsprojekte.

Arutelu lõpetatakse kokkuvõttega, kus selgitatakse, kuidas kahe etapilise käsitlusega rakendada AR-i arheoloogiamälestistele. Esimeses etapis leitakse seos ühise arheoloogiamälestise säilitamise eesmärgi ning AR kihistuse rakendamise vahel ning tuuakse välja asjaolu, et see viimasel on arvukalt positiivseid väärtuseid küllaltki madala kulu juures.

Kontseptsiooni teine etapp on magistritöö innovatiivne osa, kus luuakse võimalus külastajal digitaalset kihistust kogeda immersiiivsemalt. See saavutatakse pakkudes esiteks kohapeal võimalust laenutada AR-i prille ning teiseks võimalust jalutada mööda käiguteed, mis kujundatakse asukohaspetsiifiliste karakteristikute (eelkõige ajaloolise mahu) järgi, mille tulemusel saavad inimesed kogeda ruumi ja vaateid, mis kunagisel ajal linnuse kasutajad tarbida võisid.

Pärast teoreetilist arutelu tehakse magistritöö projektlahenduse jaoks valitud objekti Toolse linnuse analüüs, kus käsitletakse selle asukohta, ajalugu ning konserveerimist.

Magistritöö lõpeb projektlahendusega, kus on võetud loomingu aluseks objekti analüüs ning teoreetilise osa kokkuvõtte, mis tõttu on jaotatud kontseptsioon kahte etappi. Esimeses etapis on esitletud esmalt autori poolt läbiviidud fotogramm-meetriat ning seejärel spekulatiivset linnuse endise mahu rekonstruktsiooni. Etapp lõpeb visualiseeringuga, mille eesmärk on kirjeldada AR-i kogemust ning mahtu, mida võib, arvestades tehnoloogia arengu kiirust, vaateleja objektile kogeda järgnevate aastate jooksul.

Teises, selle magistritöö innovatiivses etapis, on esitletud käiguteed, mis on kujundatud pidades silmas teoreetilise osa lõpus väljatoodud karakteristikuid, eesmärgiga olla lugupidav pärimusliku väärtusega materjali suhtes. Lisaks on visualiseeritud projektlahenduse ja digitaalse kihistuse mahu vahelist harmooniat.

Magistritöö eesmärgi saavutamiseks tehti arhitektuurne ettepanek Toolse linnuse näitel, kus kontseptsioon jaotati kahte etappi. Töö tegemine andis autorile juurde palju teadmisi ajalooliste objektide säilitamise, konserveerimise ning AR tehnoloogia võimaluste ja arengu kohta.

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EXTRAS

Extra 1. List of documentation of Toolse Castle provided by Heritage Conservation Agency. 2021

1	Lääne-Viru maakond Vihula vald Toolse küla. Toolse linnuse varemed. 2008.a. avarii-konserveerimistööde muinsuskaitsejärelevalve aruanne. A-8438	Arhivaal	Muinsuskaitseameti arhiiv	ERA.5025.2.9405	2008	19
2	Lääne-Viru maakond, Vihula vald, Toolse küla. Toolse linnuse varemed. Põhjaosa võlvi ja müüritise avarii-konserveerimistööd. P-16471.	Arhivaal	Muinsuskaitseameti arhiiv	ERA.5025.2.12975	2012	17
3	Lääne-Viru maakond, Vihula vald, Toolse küla. Toolse linnuse varemed, osaline konserveerimine. P-16600.	Arhivaal	Muinsuskaitseameti arhiiv	ERA.5025.2.13452	2013	17
4	Lääne-Viru maakond, Vihula vald, Toolse küla. Toolse linnuse varemed. Varemete kagupoolse osa avarii-konserveerimistööd. Muinsuskaitsejärelevalve aruanne. A-11941	Arhivaal	Muinsuskaitseameti arhiiv	ERA.5025.2.14084	2011	19
5	Lääne-Viru maakond, Vihula vald, Toolse küla. Toolse linnuse varemed. Varemete põhjaosa võlvi ja müüritise avarii-konserveerimistööd. Muinsuskaitsejärelevalve aruanne. A-11942	Arhivaal	Muinsuskaitseameti arhiiv	ERA.5025.2.14085	2013	14
6	Lääne-Viru maakond Vihula vald Toolse küla. Toolse linnuse varemed. Avarii-konserveerimistööd. A-7753	Arhivaal	Muinsuskaitseameti arhiiv	ERA.5025.2.8721	2007	15
7	Lääne-Viru maakond, Vihula vald. Toolse linnuse varemed. Tehnilise olukorra üldhinnang ja I etapi kindlustamis-konserveerimistööde põhiprojekt. P-16715	Arhivaal	Muinsuskaitseameti arhiiv	ERA.5025.2.14136	2004	65
8	Lääne-Viru maakond Vihula vald Toolse küla. Toolse linnuse varemed. Kaevand. Arheoloogiliste tööde järelevalve aruanne. A-8281	Arhivaal	Muinsuskaitseameti arhiiv	ERA.5025.2.9248	2008	15
9	Lääne-Viru maakond Vihula vald Toolse küla. Toolse linnuse varemed. 2009. a. avarii-konserveerimistööde muinsuskaitsejärelevalve aruanne. A-9364	Arhivaal	Muinsuskaitseameti arhiiv	ERA.5025.2.10332	2010	15
10	Lääne-Viru maakond Vihula vald Toolse küla. Toolse linnuse kaitsevöönd. Ettepanek ehitiste püstitamiseks. A-6830	Arhivaal	Muinsuskaitseameti arhiiv	ERA.5025.2.7785	2006	17
11	Lääne-Viru maakond, Vihula vald, Toolse küla. Toolse linnuse varemed. Kagupoolse osa avarii-konserveerimistööd A-10415	Arhivaal	Muinsuskaitseameti arhiiv	ERA.5025.2.12000	2011	24
12	Lääne-Viru maakond Vihula vald Toolse küla. Toolse linnuse varemed. Põhjaosa võlvi avarii-konserveerimistööd. P-15798	Arhivaal	Muinsuskaitseameti arhiiv	ERA.5025.2.11055	2010	14
13	Lääne-Viru maakond, Vihula vald, Toolse küla. Toolse linnuse varemed. Varemete osaline konserveerimine. Muinsuskaitsejärelevalve aruanne. A-11944	Arhivaal	Muinsuskaitseameti arhiiv	ERA.5025.2.14087	2014	15
14	Lääne-Viru maakond, Vihula vald, Toolse küla. Toolse linnuse varemed. Varemete osaline konserveerimine. Muinsuskaitsejärelevalve aruanne. A-11943	Arhivaal	Muinsuskaitseameti arhiiv	ERA.5025.2.14086	2013	13
15	Lääne-Viru maakond, Vihula vald, Toolse küla. Toolse linnuse varemed. Varemete põhjaosa võlvi avarii-konserveerimistööd.	Arhivaal	Muinsuskaitseameti arhiiv	ERA.5025.2.14083	2010	19

	Muinsuskaitsejärelevalve aruanne. A-11940					
16	Lääne-Viru maakond Vihula vald Toolse küla. Toolse linnuse varemed. Kagutorni konserveerimistööde muinsuskaitsejärelevalve aruanne. A-7752 CDI fotod	Arhivaal	Muinsuskaitseameti arhiiv	ERA.5025.2.8720	2006	111
17	Lääne-Viru maakond, Vihula vald, Toolse küla. Toolse linnuse varemed. Konserveerimine. Hooldusjuhend-tegevuskava. A-12387	Arhivaal	Muinsuskaitseameti arhiiv	ERA.5025.2.14982	2015	21
18	Lääne-Viru maakond Vihula vald Toolse küla. Toolse linnus. Toolse linnuse varemetele kaitsevööndi kehtestamise ettepanek. A-5454	Arhivaal	Muinsuskaitseameti arhiiv	ERA.5025.2.6428	2004	14
19	Lääne-Viru maakond Vihula vald Toolse küla. Toolse linnus. Varemete kindlustusprojekt. P-11473	Arhivaal	Muinsuskaitseameti arhiiv	ERA.5025.2.1004	1992	14
20	Lääne-Viru maakond Vihula vald Toolse küla. Toolse linnuse kaitsevöönd. Ajutiste rajatiste paigutuse ja arhitektuurse lahenduse projekt. P-13762	Arhivaal	Muinsuskaitseameti arhiiv	ERA.5025.2.3166	2006	18
1	Eesti keskaegsed linnused. Toolse, Vastseliina ja Laiuse linnuste uurimise aruanne. Kd II. K. Aluve. A-1466	Arhivaal	Muinsuskaitseameti arhiiv	ERA.T-76.1.11716	1985	49
2	Eesti linnad ja linnused graafikas. 5. osa (Toolse - varia). K. Kaplinski. A-714	Arhivaal	Muinsuskaitseameti arhiiv	ERA.T-76.1.10938	1982	62
3	Vihula vald, Toolse linnus. Maa-ala geodeetiline plaan. U. Hermann. P-2053	Arhivaal	Muinsuskaitseameti arhiiv	ERA.T-76.1.1885	1974	3
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5	Vihula vald, Toolse linnus. Fotod. Kd V. K. Aluve. A-1344	Arhivaal	Muinsuskaitseameti arhiiv	ERA.T-76.1.11594	1985	20
6	Vihula vald Toolse küla. Toolse linnus. Kaust 887	Arhivaal	Muinsuskaitseameti arhiiv	ERA.T-76.1.18027	1964	-
7	Vihula vald, Toolse linnus. Ettekanne isetegevuslike koristustööde kohta 30. juuni - 4. juuli 1986. K. Altoa. A-1003	Arhivaal	Muinsuskaitseameti arhiiv	ERA.T-76.1.11249	1986	10
8	Vihula vald, Toolse linnus. Varemete esialgse tehnilise ülevaate tulemused ja edaspidi vajalike uurimistööde loetelu. V. Buldas. P-580	Arhivaal	Muinsuskaitseameti arhiiv	ERA.T-76.1.537	1964	2
9	Vihula vald, Toolse linnus. Fotod. P-580-a	Arhivaal	Muinsuskaitseameti arhiiv	ERA.T-76.1.538	1964	25

LIST OF GRAPHIC COMPONENTS

Illustration 1 The ruins of Laiuse castle (Source: <https://register.muinas.ee/public.php?menuID=monument&action=view&id=23932>)

Illustration 2 Muinsuskaitseameti toetused (Source: <https://www.muinsuskaitseamet.ee/et/jagatud-toetused>)

Illustration 3 The portrait of John Ruskin (Source: <https://www.theguardian.com/artanddesign/2014/oct/07/john-ruskin-emma-thompson-mike-leigh-film-art>)

Illustration 4 The cover of The Seven Lamps of Architecture (Source: <https://piclick.com/Book-The-Seven-Lamps-of-Architecture-by-John-390001218902.html>)

Illustration 5 The ruins of Angerja castle (Source: https://et.wikipedia.org/wiki/Angerja_vasallilinnus#/media/Fail:Angerja_linnuse_varemed.jpg)

Illustration 6 The conservation of the Notre-Dame de Paris church (Source: <https://edition.cnn.com/style/article/notre-dame-cathedral-fire-anniversary-rebuild/index.html>)

Illustration 7 The Kiyomizu-dera "Pure Water Temple" in Japan (Source: <https://en.wikipedia.org/wiki/Kiyomizu-dera#/media/File:Kiyomizu.jpg>)

Illustration 8 The restored 19th century home with corten addition (Source: <https://archello.com/project/restored-19th-century-home-with-corten-addition>)

Illustration 9 Approaches of preservation (by author)

Illustration 10 Example of Augmented reality on archeological site with smart phone (Source: https://www.researchgate.net/figure/Tourist-sees-augmented-reality-through-his-tablet-author_fig4_325049910)

Illustration 11 Example of Augmented reality on archeological site (Source: https://www.researchgate.net/publication/268075850_3D_Visualization_via_Augmented_Reality_The_Case_of_the_Middle_Stoa_in_the_Ancient_Agora_of_Athens)

Illustration 12 and 13 Example of augmented reality on archeological site (Source: https://www.researchgate.net/publication/307530266_VIRTUAL_RECONSTRUCTION_OF_LOST_ARCHITECTURES_FROM_THE_TLS_SURVEY_TO_AR_VISUALIZATION)

Illustration 14 and 15 Example of Augmented reality on archeological site (Source: https://www.researchgate.net/publication/325049910_The_Cultural_And_Economical_Impacts_Of_Using_Virtual_Heritage_In_Archaeological_Sites_In_Egypt)

Illustration 16 Augmented reality as the extension of approaches of preservation (by author)

Illustration 17 The concept of Phase II – Immersive AR (by author)

Illustration 18 The ruins of Toolse castle (Source: <https://www.visitestonia.com/en/toolse-order-castle>)

Illustration 19 Location diagram (by author)

Illustration 20 The existing site (by author)

Illustration 21 The historical elevations and site (Source: Muinsuskaitse Eritingimused Toolse Linnusevaremete Konserveerimiseks. 2004)

Illustration 22 The latest floor plan with construction stages of Toolse castle based on K. Aluve's (1993) drawings (by author)

Illustration 23 The history of conservation of Toolse castle (by author)

Illustration 24 and 25 The conservation of Toolse castle (Source: <https://register.muinas.ee/public.php?menuID=monument&action=emergencysupport&id=15951>)

Illustration 26 Author flying the DJI Phantom Pro V2 drone for photogrammetry by Author's friend

Illustration 27 The dronedeploy software (Source: <https://www.dronedeploy.com/>)

Illustration 28 The model of the Toolse castle done with photogrammetry with dronedeploy software (by author)

Illustration 29 The 3D reconstruction diagram (by author)

Illustration 30 Footage from site (by author)

Illustration 31 The reconstructed AR layer of Toolse castle. Added on footage with CGI in order to illustrate the AR experience possible in a few years (by author)

Illustration 32 The modular construction system of the walkaway (by author)

Illustration 33 the plan of PHASE II – Immersive AR 1 : 200 (by author)

Illustration 34 The trajectory of the walkaway (by author)

Illustration 35 The view from to the east on the walkaway (by author)

Illustration 36 Birdview of the project (by author)

The view from the north (by author)

Illustration 37 The view from to the west on the walkaway (by author)

Illustration 38 Section L-1 (by author)

Illustration 39 Section L-2 (by author)

Illustration 40 Elevation from the south (by author)

Illustration 41 Elevation from the north (by author)

Illustration 42 Elevation from the east (by author)

Illustration 43 Elevation from the west (by author)

Illustration 44 The view from the north (by author)

Illustration 45 The view from the south-east (by author)

Illustration 46 The plan of the pavillion (by author)

Illustration 47 The section D-2 of the pavillion (by author)

Illustration 48 The interior of the pavillion (by author)

Illustration 49 The view from the north (by author)

Illustration 50 The reconstructed AR layer of Toolse castle with walkaway. Added on footage with CGI in order to illustrate the AR experience possible in a few years with the walkaway (by author)

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