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HERITAGE RECORDING WITH 3D LASER TECHNOLOGY: THE CASE OF LORD' S BATH (BEY HAMAMI) IN MUĞLA, MİLAS

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Abstract

Heritage Recording is one of the key activities in conservation works for immovable cultural heritage. Especially the first survey is of high importance since it serves as the base for every kind of analyses, investigations and interventions. Every act of conservation should be done and recorded on this base systematically. 3D Laser Scanning was chosen for high accuracy and enabling of systematic work. In this study, a medieval bath from Western Anatolia, Lord' s Bath (Bey Hamamı) in Beçin Archaeologic Site and Natural Reserve of Muğla, Milas County was scanned and documented with this technology in order to guide future conservation studies.

1. INTRODUCTION

The graphic or photographic capturing of information describing the physical configuration, evolution, and condition of a heritage at known points in time is Heritage Recording [1]. This not only helps professionals to retain the knowledge they need for conservation activities, but also helps present and future generations to preserve cultural values. From this point of view, the medieval heritage in Anatolia is worth saving. In medieval ages, every principality in Anatolia had its own style, hence Anatolia in Principalities Period offers a great variety of architectural features with different types of buildings. Amongst the building types in this period, baths are very distinctive with their heating and sanitary system technologies. In this study, a bath from Menteshe Principality Period, namely Lord' s Bath (Bey Hamamı) which is also remarkable with its decorations was documented with 3D Laser Scanning technology.

Currently, Beçin is registered as a first and third degree archaeological site and a natural reserve. Excavations are maintained under the auspices of Ministry of Culture and Tourism of Turkey. Since 2016, Prof. Dr. Kadir Pektaş has been chairing the excavations.

Settlement History

The City of Beçin has a special place in Principalities Period Architectural History in Western Anatolia because, it still retains authentic architectural features of the period as a whole city. The influence of Ottomans on architectural heritage cannot be observed in this city as it was abandoned at the beginning of 17th century [2] after a long period of political struggle; wars with Byzantine Empire, other 489inör principalities and Ottomans [3]. After conquering Menteshe Principality fully, Ottomans only renewed the inner castle (fig.1-a) since they did not consider the city valuable [4]. The settlement was infrequent, impermanent and rather rare after this period. In 2012, last remaining residents (fig.1-b) moved out from the inner castle and the settlement of Turkish people which started in 13th century [5] came to an end.

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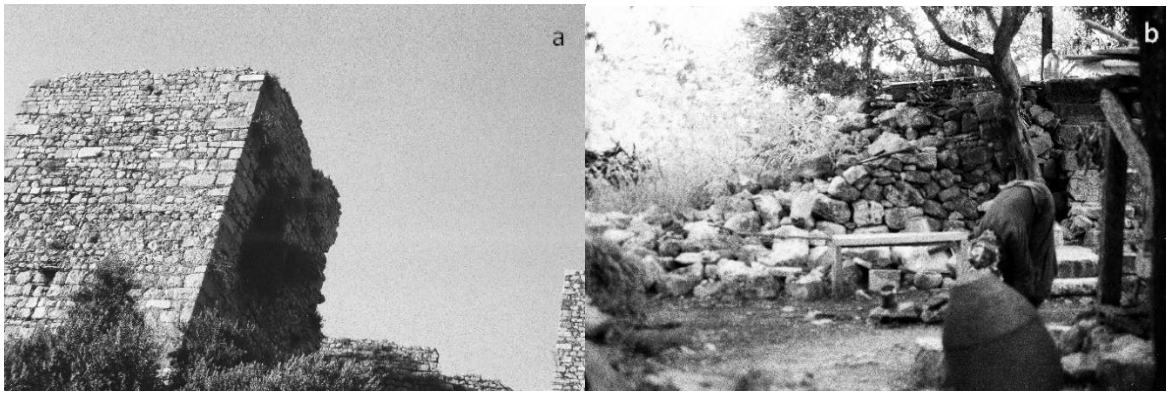

Fig.1 The Castle and One of the Last Residents, Gökçe Altay's Archive, 2012

The City

The city radiates from an inner castle to the Southern direction and divided in half by the outer castle walls as can be seen in the maps below (fig.1-a). Castle walls, madrasas, Mosques, tombs, Islamic monasteries, baths, inns, mansions, houses, cemeteries, military quarters, fountains and other water structures are the types of structures that can be seen in the city. More than half of the structures do not have roofing due to earthquakes and neglect. Today, the City of Beçin offers a picturesque scenery of a ruined medieval city in a green national reserve (fig.1-b) which would be a fit for John Ruskin's ideas. According to Arel, the city itself enough to enlighten the manner of Turkish settlement in Anatolia [6].

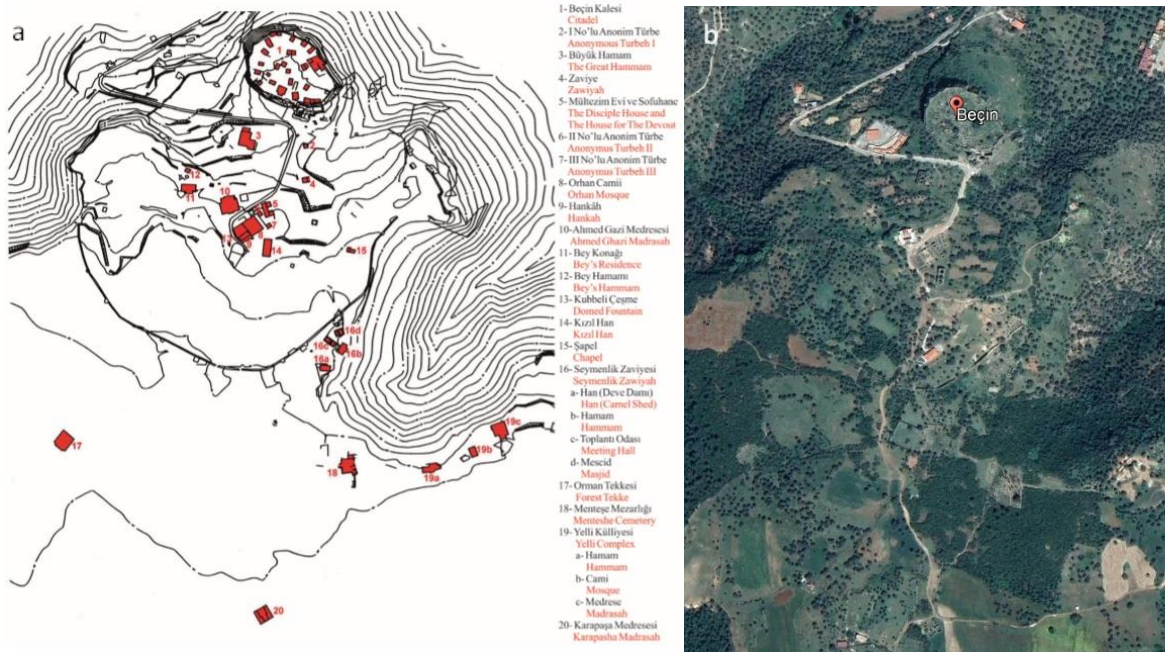

Fig.2 Beçin City Map (a) [7] and Google Earth Image (b) (2019)

The Bath

Fig.3 Entrance of Hot Room (a) and Furnace (b), Gökçe Altay's Archive, 2018

The Bath (Fig.3-a and b) is one of the 6 baths in the City of Beçin and was named as the Lord' s Bath (Bey Hamamı) by one of the site directors, Prof. Dr. Hüseyin Rahmi Ünal. Unfortunately, the inscription tablet of the bath was lost and since the archives of Menteshe is lost [8], It is not possible to determine the exact date of construction. The bath is dated to 15th century by Prof. Dr. Hüseyin Rahmi Ünal but a more comprehensive study can be done after the detailed documentation. According to excavation reports, only the northern seclusion of the hot room excavated in the structure. The movable cultural heritage assets can be dated back to the 15th century according to the excavation reports [9,10].

The reason of the selection of this bath for this study and makes it distinctive amongst the other structures in Beçin is its unique and rare moulded stucco decorations. These rare decorations attributes historic and aesthetic values to the bath. Due to the absence of roofing these decorations are in danger of destruction and immediate conservation interventions are needed.

2. HERITAGE RECORDING

Accurate and precise recording of cultural heritage is of vital importance because the current-state documents are the basis for conservation studies such as art history research, architectural and structural analyses, materials and deterioration analyses, determination of intervention strategies and application projects. For this purpose, 3D laser technology was chosen as a documentation method in this study.

In-Situ Process

For a well-crafted architectural survey, the obstacles around, inside and on the building should have been cleared off. For this purpose, annual plants and tree branches were trimmed. The plants on the building were trimmed very carefully since grubbing them out results in damage. Also, these plants were photographed before removal.

The architectural survey was conducted in 16 sessions for adequate resolution by FARO Focus 3D laser scanning equipment in 2 hours. The equipment can be seen in fig.4-a with the spheres used as reference points for less margin of error. In order to place the building on the Beçin city map properly, a small part of a nearby building (Lord' s Mansion) were also scanned as a reference. Considering top view, an area of approximate 830 m2 was scanned (fig.4-b). At the end of this process, raw scan data were obtained in 16 different files.

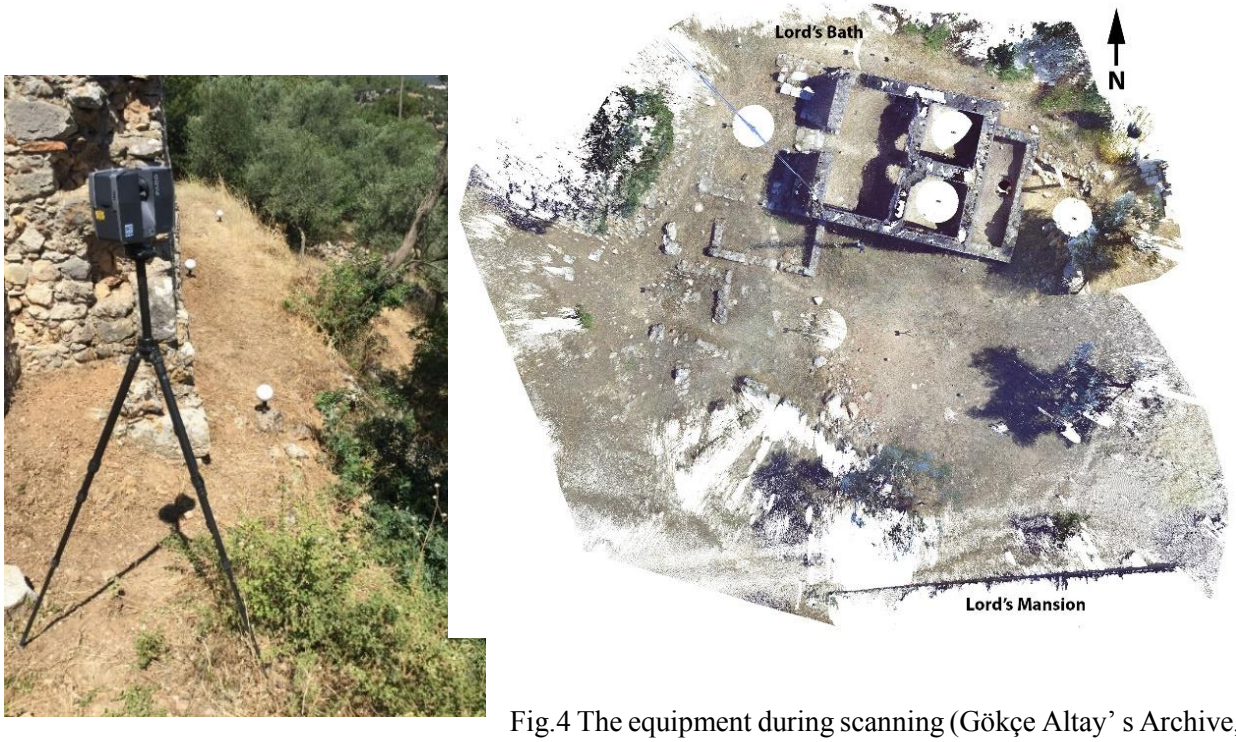

Fig.4 The equipment during scanning (Gökçe Altay' s Archive, 2019) (a) and scanned area (b)

Data Processing in Computer and Production of Architectural Survey Drawings

In this process, 16 data files were combined together via FARO Scene 2019 program and a multicolored point cloud model was obtained. Point clouds can be opened and edited in different program such as Autodesk ReCap, Autodesk Revit, Autodesk Autocad and Trimble RealWorks. In addition, different methods can be used in order to produce architectural drawings such as producing orthophotographs and drawing directly on point clouds. For this study, orthophotograph method was chosen. Working directly on 3D point cloud did not chosen as a method due to irregular shape of the building caused by severe material loss.

Orthophotographs were produced in FARO Scene (fig. 5-a). By use of clipbox command (fig.5-b), proper sections were created in order to save orthophotographs. Layers of 1:1 scaled orthophotographs in tif format were produced for the site plan, plan, facades and sections. These orthophotograph were imported into Autodesk dwg files. Lastly, the drawings were produced via Autocad program in compliance with architectural drawing standards.

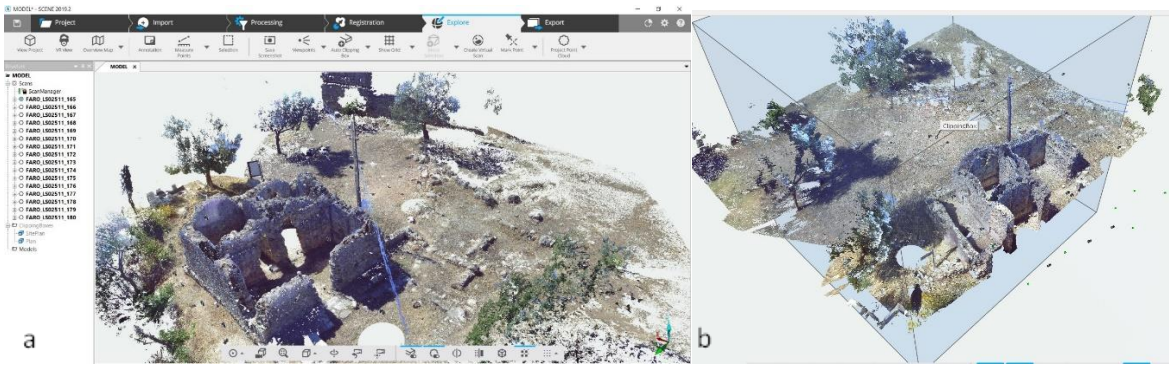

Fig.5 The program interface and the point cloud of the bath (a) and clipbox command (b)

3. BENEFITS and LIMITS OF 3D SCANNING for HERITAGE RECORDING

3D Scanning is advantageous for different phases of conservation activities for various reasons:

1- Less time consuming in situ: Comparing to traditional-manual methods and total station, 3D Scanning is less time consuming on site. While it would take at least 2 days to complete the necessary measurement for this project with the methods mentioned, 3D scanning only took 2 hours.
2- Higher accuracy: The data obtained by this method is more accurate comparing to other methods. As a result, production of drawings will be easier, of higher quality and less time consuming.
3- More convenient considering need of sophisticated drawings: Most of the time historic structures are hard to draw due to their non-linear, complicated shapes and ruined states. For this study, producing elevations and sections was a complicated work because of the state of structure. Considering facades, using different layers of sections helps to distinguish the closest view from further ones and represent this in the drawings. (Fig. 6)
4- Useful for Restitution: Architectural survey drawings constitute a base for restitution drawings. In order to achieve full understanding of architectural features of a historic building, production of these drawings is vital. In some cases, production of unusual sections are needed or number of sections must be high. The main distinction between traditional methods and 3D scanning survey is the 3D point cloud model. A 3D point cloud model gives us the opportunity to put section planes wherever we see fit and produce the high number of sections we need. With traditional methods, architects have to produce sections, plans and facade drawings with extreme effort in excessive time. In fig.7, determination of pandantive curve can be observed as a first step of restitution of the domes with the aid of a diagonal section. Another example in fig.8 depicts the restitution process of the hot room vault. The vault was demolished but, by the help of a simple section first layer of a simple pointed vault can be sketched.

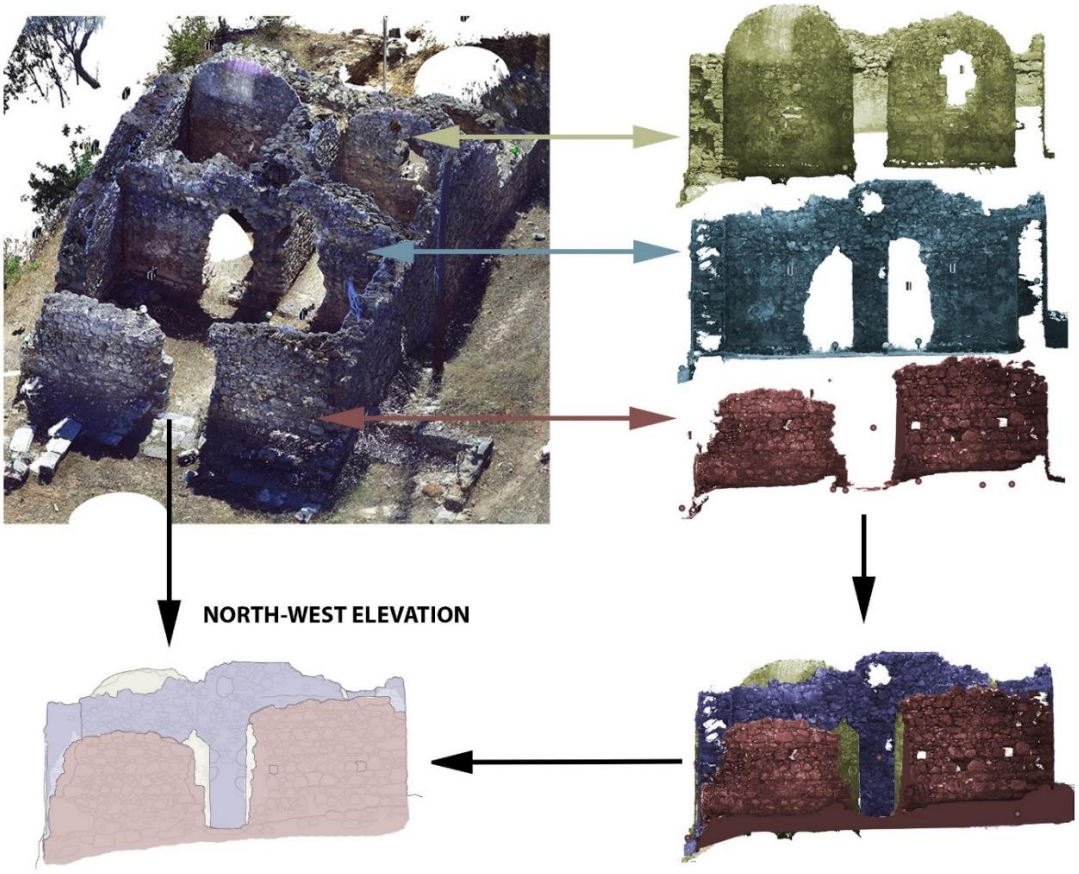

Fig.6 Diagram showing production of a facade drawing

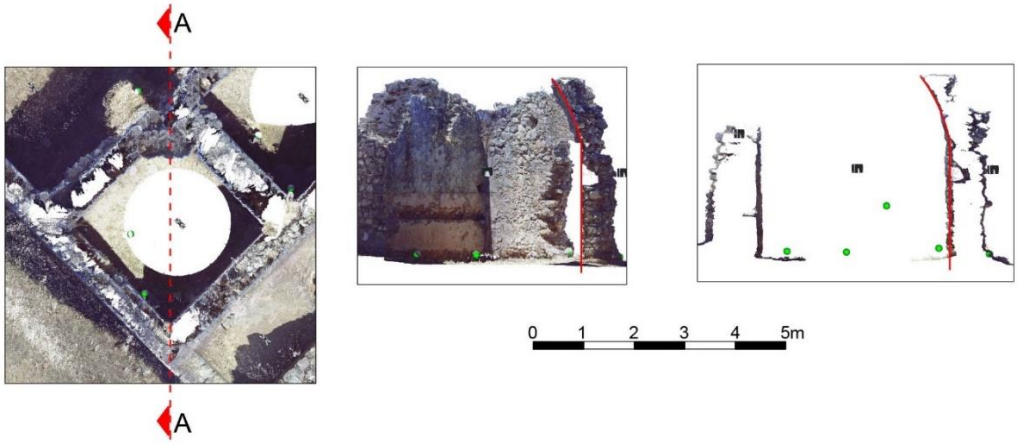

Fig.7 Determination of pandantive curve

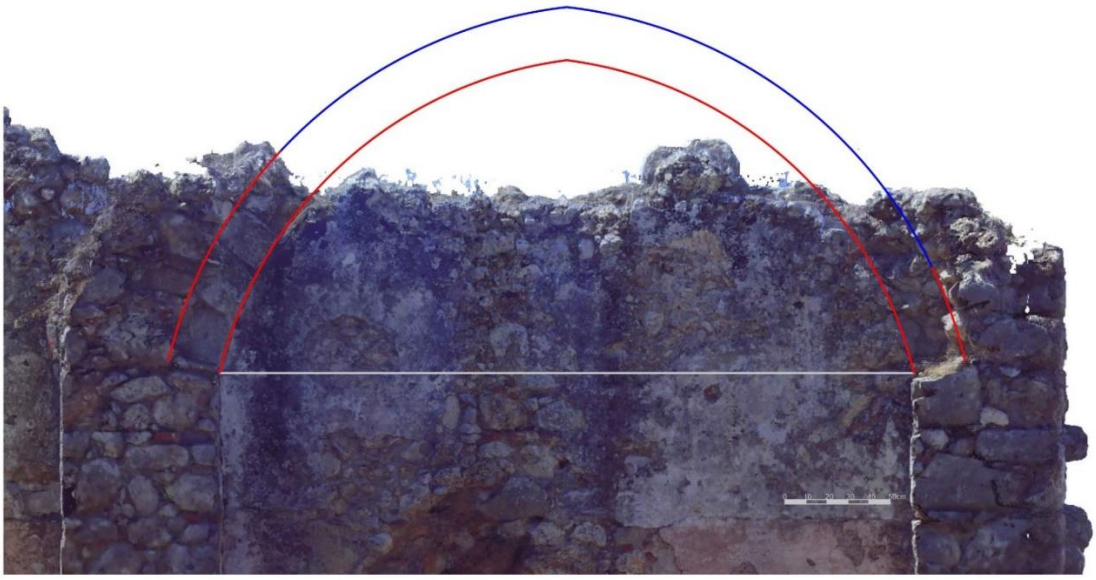

Fig.8 Restitution sketch for the vault

5- Beneficial for other types of analyses: Structural analysis of historic buildings are complicated and requires different section drawings 3D models. Production of these are less time consuming and more accurate with 3D laser technology. Different physical and mechanical properties of different building materials can be represented and analyzed as a whole.

6- Practical for application projects: Since the application of conservation projects are rather costly due to the fact that construction materials are expensive and in most of the cases are produced specifically for the structure, quantity surveys should be done properly. A proper quantity survey cannot be done without adequate and accurate drawings. If the structure is partly demolished and there is material loss on different levels, more elaborate and unusual sections are needed in order to understand the material loss and problems as shown in fig. 9.

Fig.9 Understanding the irregular material loss on walls via two different sections

Limits and abilities of the equipment should be taken into account while managing the documentation:

1- The equipment cannot be used during snowy or rainy days.
2- It is possible to produce greyscale and colorful point clouds.
3- Plants are recommended to be cleared out before scanning. It is also possible to eliminate them in the 3D Point Cloud but; since they act as obstacles, detailing will be lower.
4- Precision of the equipment may not be enough to document small decorations like shallow reliefs, especially when there is not any color difference.
5- The equipment cannot penetrate the dark parts and cavities due to the contrast created by sunlight.
6- The equipment cannot penetrate the surfaces, but images can be combined with infrared photographs easily.

4. RESULTS and DISCUSSIONS

Architectural heritage of Anatolia is disappearing because of human or nature related disasters, neglect and wrong conservation interventions, most of the cases faster than we are able to document. It is conservator's duty to document cultural heritage for the sake of science, for future generations and as an insurance policy in case it is lost. Because of the historic, artistic and technological values It carried, Lord' s Bath is worth documenting and saving. Key points on the results of the study is can be summarized as following:

• For this study, 3 plans, 4 facade drawings and 12 sections are produced.
• Moulded stucco decorations are documented separately, because laser scanner's precision was not enough (fig.10-a/b)
• Hypocaust was added to the drawings after superposition of the latest plans and 1995 plans as it is currently underground.
• Sanitary system and fume outlets are depicted in necessary drawings by the help of hand measurements since laser scanner cannot penetrate dark parts and surfaces.
• After types of stones used in the bath was determined with analytical methods, mapping of these was done in situ by coloring CAD drawings digitally with a tablet.
• The brick pieces used in the masonry work, which is a common construction method for the period, was mapped in the drawings by means of color difference.
• Embedded scaffolding holes were depicted in the drawings (fig 6). Some of the holes were plugged on the other sides of the walls, these also were projected to the other sides properly. This will be helpful during the application of the conservation project.

Fig.10 Moulded stucco decoration (Gökçe Altay' s Archive, 2018)(a) and drawing (Gökçe Altay, 2019)(b)

3D Laser Scanning was proved advantageous considering irregular shape and deteriorated condition of the structure. Although measurements were taken when necessary, laser technology reduced this action to a minimum. This technology is not only beneficial for theoretical steps of conservation like restitution and project discussions, but also for practical steps like structural analysis, quantity survey and on-site applications.

5. ACKNOWLEDGEMENTS

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