

Non-destructive Prospection of Ancient Steam Bathes Covered with Tadelakt

First Preliminary Comparison of Hammam Kasbah des Caid's of Tamnougalt and Hammam Kasbah of Taourirt, Morocco

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Keywords: Morocco, Lime Plaster, Tadelakt, Hammam, Kasbah, Tamnougalt, Taourirt

Abstract. Nowadays the use of authentically, natural building materials for the preservation of monuments ends, where moisture and steam arises: in climatically challenging rooms like baths, kitchens, saunas, SPAs

By reference to two of the oldest steam bathes (hammams) of Morocco we can try a more scientific view on the problem by focussing this kind of ancient architecture, which presents us the capability to protect earth building units by compressed, hydrophobized lime plasters.

Reported are the preliminary results achieved with non-destructive prospection of the old steam bathes by use of a 3D laser scanner with integrated colour camera.

Introduction

The various use of high developed building materials in the past decades obscure the general lack of ecological production and the missing of eco-friendly disposal, respectively the capability of recycling. This brings us back to the original, natural building materials like earth and makes them become contemporary and modern again.

But, nevertheless, the use of earth building units or earth plasters in wet areas is a challenge up to now. This argues for more scientific research with the focus on this kind of ancient architecture, which demonstrates the use of building materials under climatically extreme conditions like increased humidity and high temperature.

A special way to protect the front of earth buildings or special stressed internal walls by for example lime is known to us from Morocco: the established lime plaster and as well building technique called 'Tadelakt'. By this time we have to distinguish as well between the original Tadelakt, a highly hydraulic lime from the hills surrounding Marrakech, slightly contaminated by the firing process, and the mixture of different, natural substances like hydraulic lime, white hydrated lime, dolomite powder, marble and quartz sand, clay and cellulose. This artificial mixed Tadelakt is produced by several companies nowadays. This article focuses on the original lime from Morocco.

Tadelakt plasters are compressed and afterwards hydrophobized by application of a soap, which makes them become water repellent. Their surface is very smooth and shiny and the plaster can be coloured by pigments. This brilliant, aesthetical and handcrafted complex polished lime plaster is to be found at a lot of places in Morocco – until today. As a design element in restaurants and hotels or as a functional protection (roofs and walls are protected by it) in (steam) bathes, showers. Latter are of special interest for us. To learn some more about the characteristic of Tadelakt, the analysis of ancient plasters in extreme conditioned rooms like hammams (steam bathes) may be illuminating.

The structural-physical and -chemical analysis of Tadelakt aims for general conclusions for the adaptability of this earth protection technique for the European area.

Detailed knowledge about the usage and the special features of Tadelakt and out of it the developed building material guidelines, could help to close the gap and to allow a consequent use of natural building materials, even in rooms with special climatic demands, like (extreme) high humidity or direct water contact in the European cultural area in the field of old-building renovation/monumental conservation as well as new ecological construction.

Besides the laboratory-analytical approach to Tadelakt that already brought out interesting results [1], the descriptive-empiric way of research is interesting and should be addressed in this article.

History

The south of Morocco, the part between the Sahara and the High Atlas mountains, stands out due to a special architectural use of forms. Tribe living castles, called kasbahs, harboured in former times extended families. Many kasbahs in the south of the Atlas, contemporary witness of the Trans-Saharan trade, were strategically positioned and played an important role for the dromedary trains.

The kasbahs have several floors and tower above the surrounding village, called ksar. These very impressive buildings, relicts from the 16th/17th century or younger, are constructed almost entirely from earth and some of them are in good preservation up to now.

Coming back to the Tadelakt, one can assume that the probably oldest kasbahs in the south of Morocco entail the oldest hammams and thus the oldest extant Tadelakt plasters.

The hammams had an important religious and hygienic function for the Tuaregs and Berbers to become physically and spiritual clean again.



Fig. 1 Tribe living castle in the south of Morocco, Kasbah Taourirt, Ouarzazate



Fig. 2 Position of Tamnougalt and Taourirt not far from the desert [2]



Fig. 3 Kasbah des Caids of Tamnougalt, view from the palm garden in the Draa valley

The probably oldest preserved Tadelakt plasters can be found in a steam bath of the supposed to be oldest kasbah in the Drâa-valley in Tamnougalt, south of Atlas Mountains [3] (Fig. 2+3). The name Tamnougalt means 'place of meeting' and is based on the geographic position from the caravan routes between Fes and Timbuktu. The original kasbah from the 16th century was supposed

to be built by the first Caid of Mezguita Region. It is located in a convoluted built ksar (village from earth, fortified settlement, see Fig. 4) and was extended by two further directly attached castles. In their architectural design vocabulary they mix Arabic elements with elements from the Berber culture.

Mainly by the individual initiative of Hassan Ait el Caid, the engaged descendant of the tribe Ait el Caid and one of the authors, the ksar was renovated and is still inhabited by approximately ten families.

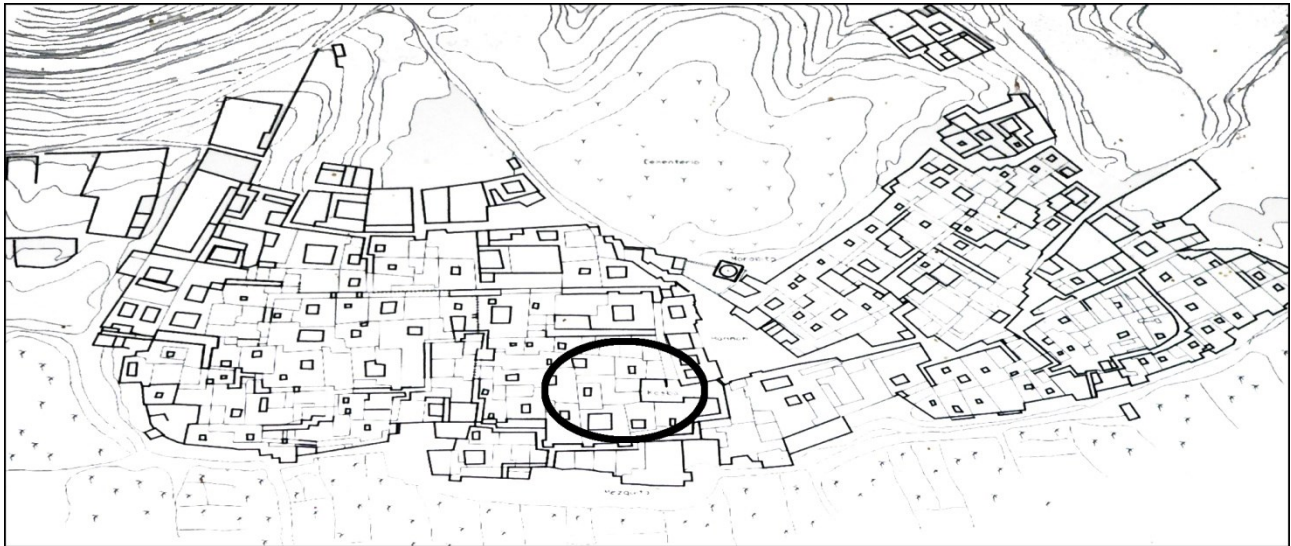


Fig. 4 Sketch of urban building of Tamnougalt with marked position of the kasbah complex (from auberge chez yakob)

The kasbah of Taourirt in Ouarzazate was built 1754 and dominated by one of the Caids in Tamnougalt. The kasbah became to Pasha Glaoui by a marriage in 1940 between two Glaoui men and two Caid daughters. Pasha Glaoui sold the kasbah to the commune rural of Ouarzazate in 1986. The kasbah has an interesting ancient hammam inside and is in general very well restored by the CERCAS, the Center for Conservation and Rehabilitation of the architectural Heritage of the Atlas and sub-Atlas zones.

Intention

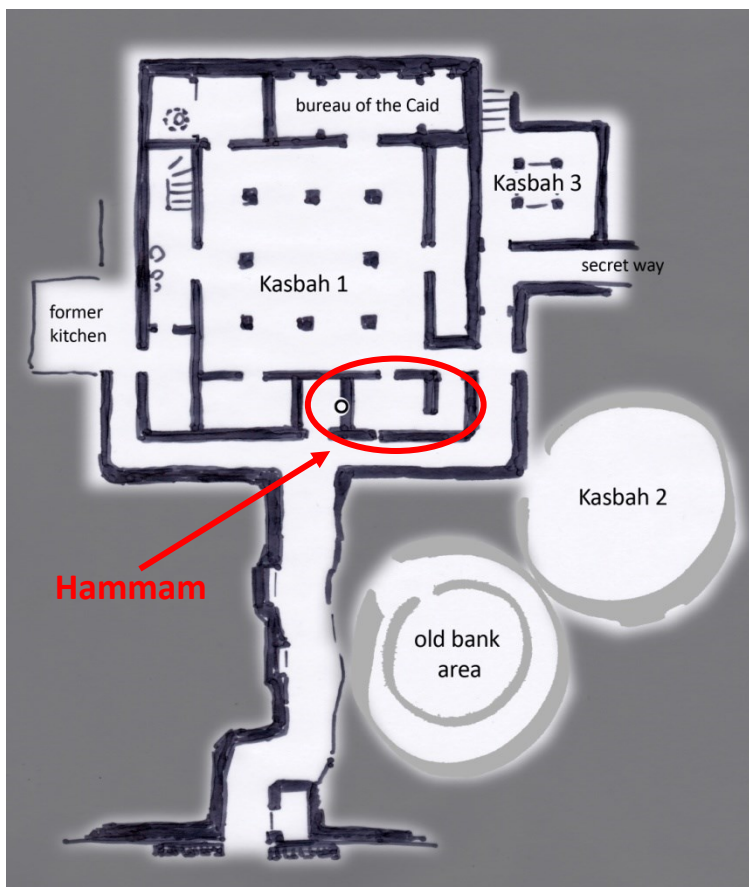
To learn something about the Moroccan way to protect earth from water, we have to analyse the historical development of the kasbahs and especially the hammams inside. To adapt the lime plaster Tadelakt to European requirements it is important to know the parameters, Tadelakt was originally exposed. How was the climatic amplitude in the hammam, respectively which building physical conditions Tadelakt had to resist?

To analyse the property of the south Moroccan hammams, a holistic view would be necessary. Resource-limited the various interesting research questions cannot be answered in this project. Their handling seems to be useful within the context of a joint research project. For example the analyses of social aspects like for example the question by whom the hammams has been used originally? Were they just private or as well for guests, maybe for the Berbers coming through the desert, maybe for commercial negotiations?

Moreover many questions of urban building came up like: when was the first of the three kasbahs in Tamnougalt and thus the hammam inside built exactly? Here maybe the analysis of some wood samples by use of the Radiocarbon method would be enlightening. Which individual phases of construction are visible and were the kasbahs regularly renovated?

Of special interest and close connected to the building-physical questions are the technical questions. As a consequence following research questions are in space:

- How was the hammam provided with hot and cold water, with steam and heat?
- Where did the waste water run?
- Where escaped the exhaust air?
- Which function had the Tadelakt?
- Why the polished plaster in the lower part of the walls does not exist anymore (hammam Tamnougalt)?
- Why the ceiling had to be already renovated and why the adherence of the Tadelakt is insufficient at some places (hammam Taourirt)?
- How has the bath been taken (sitting or lying)?
- Was there a second drawn ground where hot air flowed underneath (hammam Tamnougalt)?
- Where are the changing rooms located?
- Which function do the different built niches in the walls have (s. Figs. 8,9,11,12)?



To answer these questions actually the mapping of the whole kasbahs would be relevant. In literature you can find an attempt of students of the ETH in Zurich to measure the Kasbah des Caids of Tamnougalt [4], but the last inspection in September 2013 negated the groundplan. The Kasbah des Caids of Tamnougalt is composed of three smaller kasbahs and is built nested. Some parts are in danger of collapsing, some has been converted and some are still inhabited.

The following preliminary ground-plan gives an impression of the positioning of the hammam within the kasbah.

In this research project the measurements are for now limited to the hammams and their secondary rooms.

Fig. 5 First preliminary ground plan sketch of the central part with the oldest Kasbah des Caids of Tamnougalt

Technology

The two rooms of the hammam in Kasbah des Caids of Tamnougalt have a notably sophisticated ceiling structure that is hard to prospect with a yardstick or a measuring tape. Moreover, the ancient preserved Tadelakt plaster should not unnecessarily be touched. Therefore, it was clear to use a

non-destructive, optical measuring technology like a laser scanner to get an idea of the arrangement of the rooms and their functional connections. In this project a 3D laser scanner with integrated colour camera was used. The colour camera allows combining the automatically generated digital colour pictures with the measured point cloud.

During the measurements in September 2013 it became clear, that this technology is of limited use in warm areas like in Morocco. Using the scanner with power connection the scanner becomes quickly very hot and has to cool down after a few measurements. For a longer application the lorry of second batteries is recommended.

Another challenge was the homogenous illumination of the really small rooms without shadows. Ideal is the illumination with a homogenous, diffuse daylight for the colour camera pictures. Otherwise sharp shadows disturb the presentation of the scanned objects.



Fig. 6 3D laser scanner in the main room of the hammam in kasbah des Caids of Tamnougalt



Fig. 7 Ceiling and walls are covered with Tadelakt, a special lime plaster



Fig. 8+9 Two different niches and a small arched wall penetration, probably for the heating system

The Hammams of Kasbah des Caids of Tamnougalt and Kasbah of Taourirt

General Description. The hammam of Kasbah des Caids of Tamnougalt is located in the biggest and supposed oldest part of the kasbah (Fig. 5). From a central asfallo, an open to the top connection room with columns and many doors, leads a narrow doorway to the windowless hammam. It is apparently in a good condition. The ceiling is shaped with a ribbed vault and the upper part of the ca. 4m high room with an area of 2,3 x 2,8m is furnished with Tadelakt. The lower parts of the four walls are shaped with brick but show clear tracks of former plaster. In places, some blackish dark brick stones can be recognised between red flat bricks. Further surveys will show if it is about earth- or lime plaster.

The transition from unplastered walls to good preserved plastered walls is irregular (s. Fig. 6). According to our investigations the lower part of Tadelakt has been removed to convert parts of the kasbah into a hostel. This idea has never been put into practice.

In Kasbah of Taourirt the hammam could be reached via a large open patio. There is a big vestibule with a separate room opposite the entrance and a very low-rise corridor to the small hammam rooms and another room. All rooms are renovated. The two hammam rooms, as well very low-rise and small with about 2m height and 1,10x2m or 0,8x2m, are plastered with Tadelakt in a different conservation status and they are partly extemporary secured.

Both hammams are not in use anymore.



Fig. 10 Laser scanner in the very low-rise rooms of the hammam in kasbah Taourirt



Fig. 11+12 Different shaped niches and holes, probably for fresh air and for the heating system

Spacial Relations. The hammam room in Tamnougalt is connected with another Tadelakt-covered room with the same sophisticated ceiling structure by a narrow passage without a door. This second hammam room is narrow and seems like a vestibule to the main hammam. The second room has another entrance from the corridor. The study of the two entrances to the hammam area revealed that the hammam entrance from the asfallo has been built afterwards. The architecture of other historical hammams – as for example the one of kasbah Taourirt – and the economy of the method of heating confirm this assumption.

The hammam of Tamnougalt has two differently shaped niches in the wall between the supposed fire room and the hammam itself. They are about 80 or 110cm above the actual floor and around 40 or 60cm deep. They show brick surface and one is partly coloured. The hammam of Taourirt has a niche as well which is combined with a pipe connection to the patio and consequently to fresh air (see Fig. 11). Şehitoğlu describes for the public baths of the Ottoman Empire niches for hammam-clogs (special shoes) [5]. Oral statements of Moroccans indicate alcoves for the storage of clothes and jewellery, but probably more for the soap and the towel.

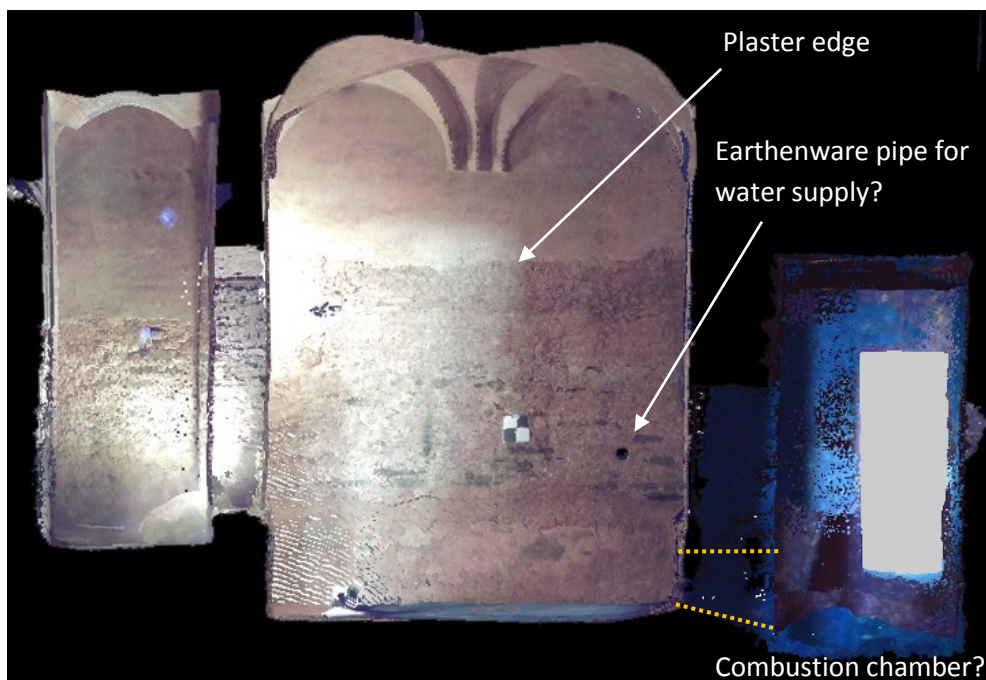


Fig. 13 Section through the two hammam rooms and another room, presumably a combustion chamber

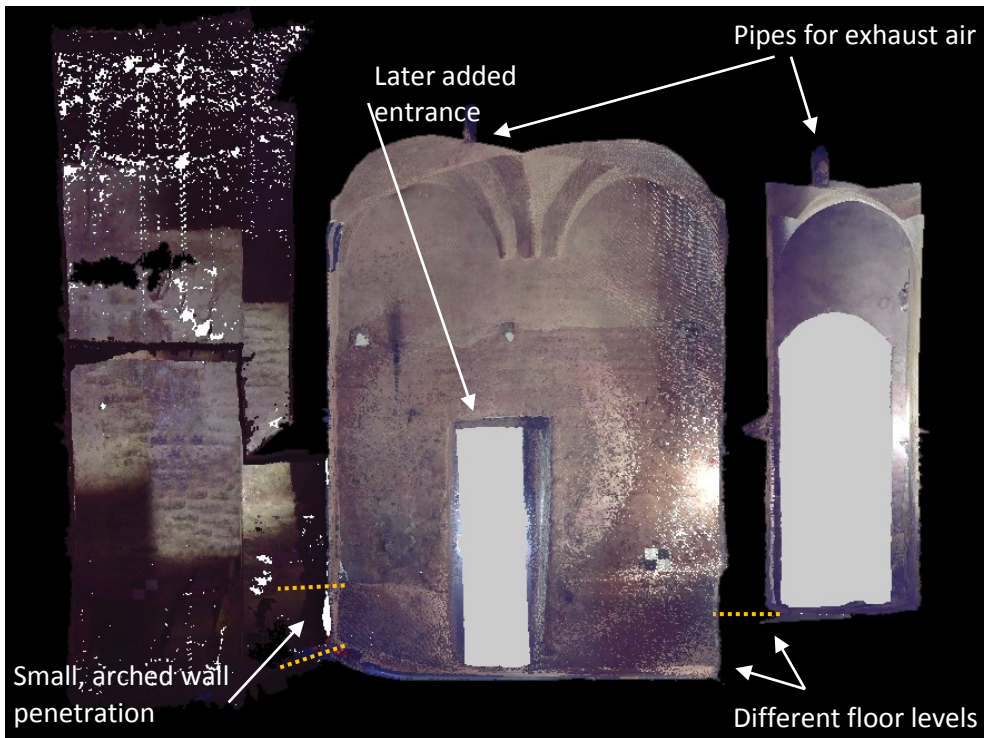


Fig. 14 Section through the hammam, first interpretation of the scanner data

Heating System, Water Supply and Steam Production. The floor levels of the two rooms of the hammam in Tamnougalt differ from each other by around 60-70cm. Together with the offset at two sides of the hammam walls in the same high it points to a former second drawn ground where hot air flowed underneath to warm up the hammam. The ground floor of the second, back room of the hammam in Taourirt has a hole. With a yardstick we could measure around 60-65cm deepness. This kind of heating complies mostly with the function of public hammams for example in Turkey. Smoke which arises from the heating of the non-potable water and steam production is lead through the canals under the ground of the bathrooms [6]. This suggests the assumption, that the first, higher levelled room, was not heated and served as a more chilly relaxation- or dressing room.

Next to the hammam room there is another small but high windowless room (Figs. 13+14), connected with the hammam by just a small arched wall penetration close to the floor. The architecture of this room and the moulding of the walls indicate that it could have been a kind of combustion chamber and storage room with probably a kind of water kettle above the fire to produce steam.



Figs. 15+16

A round wall shape in the small but high next room of the hammam, probably to supply the hammam with warmth, hot water and steam

An earthenware pipe in the wall around 1m above the floor (and consequently around 40cm above the presumed original hammam floor) leads horizontal to the corridor and ends within a Tadelakt covered wall section. The colour and character of the surface shows traces of water. According to our investigations there was a central watering place in former times in the corridor and probably the hammam was supplied with fresh water from here.



Figs. 17+18 Earthenware pipe of around 10cm diameter in the 40cm thick hammam wall

Figs. 19+20 The pipe ends within a Tadelakt covered wall section in the corridor

The hammam of kasbah Taourirt has as well a small arched connection to the next room, where probably the heat and steam has been produced. The function of the three different holes e.g. the connection to the outside (chimney) has to be examined in another research trip.

Fresh Air and Exhaust Air. The ceiling of the main hammam in Tamnougalt has two symmetrically positioned holes and the second room has one of it. The analysis of the scanner data confirmed the assumption that they are tubes highly probable for the exhaust air. The hammam of kasbah Taourirt has two connections to the fresh air (Fig. 11) and three smaller holes in another wall with the presumed heating system inside (Fig. 12).

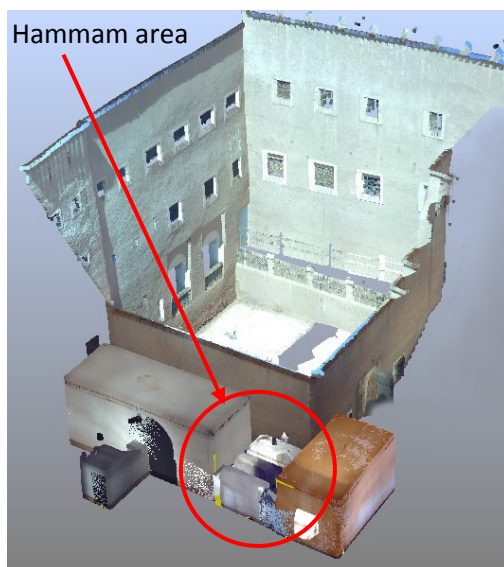


Fig. 21 3D laserscan of the area of the hammam, kasbah Taourirt, Ouarzazate

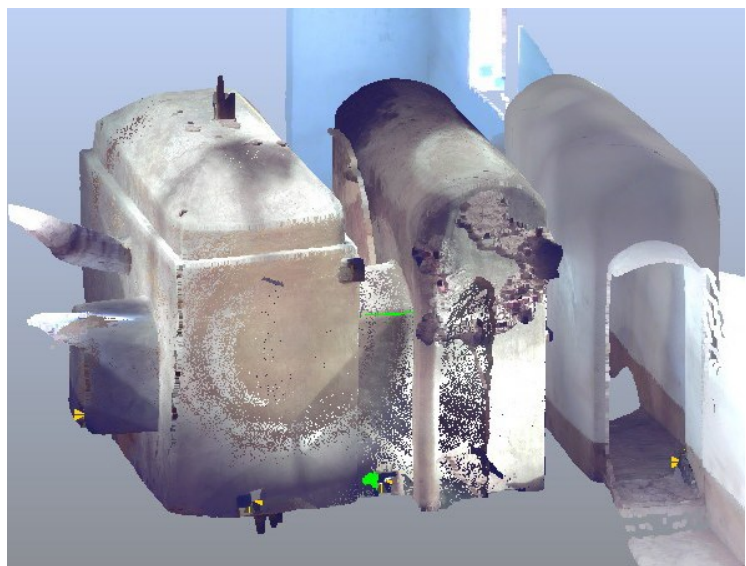


Fig. 22 3D laserscan of both hammam rooms and the lower corridor (on the right)

Conclusion

Based on the previously performed scans, photos and interviews with great probability the former function of the two examined locations could already be confirmed as hammams.

Principally, some technical questions concerning the functionality are difficult or meanwhile impossible to answer now because in the last decades some important information irrevocably got lost. Thus, a 100% response to the technical research issues will not be possible anymore.

Regarding the building physical research questions we can assume, that the preserved Tadelakt plasters in the hammam of Tamnougalt have withstood the usual climatically conditions of 45-65°C at humidity of 70-90% over around 150 years. This illustrates that Tadelakt can form a very good, workable surface protection for other building materials over a long period.

In a next step the already in laboratory tested, standardized methods for the determination of the adhesive strength and the water absorption of Tadelakt [7] should be performed locally in Morocco. Unfortunately, the method for determining the adhesive strength is not non-destructive, so that an alternative has to be found. First efforts have already been made to analyse the chemical composition of the Moroccan lime to replicate chemically identical lime plaster samples in the laboratory and to perform the tests with them.

Acknowledgement

The research project is financed by the European Social Fund for Germany in the form of a rural graduate scholarship.

The results presented in this article were made possible by the friendly support of Prof. Dipl.-Ing. Andrea Gaube from the University of Applied Sciences Wismar.

I would particularly like to thank Gaelle and Assis Ait el Caid for the open-hearted accommodation in kasbah Asslim and their engagement and organisational support, Achmed Oufent from the CERCAS, Michael Geist and his colleagues from the Fraunhofer IPA for the technical support with the interpretation of 3-D measurement data, Alexa Vollmann from the University of Rostock for the unsophisticated financial support concerning the technical equipment, Jessica Bernert from the women promotion pool of the University of Applied Sciences Wismar for the financing of two research trips to Morocco and firm Kubit for the lending of a FARO SCENE laser scanner.

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