H.A.M.M.A.M. Project and Climate Design of Islamic Bath Buildings

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ABSTRACT: The "Hammam, Aspects & Multidisciplinary Methods of Analysis for the Mediterranean region" project H.A.M.M.A.M. aims to develop scenarios for the adaptive reuse of the hammam buildings as public service centres for Islamic Mediterranean cities. Approved and financed by the European Union, it gathers experts half from Oriental/South Mediterranean countries and half from European ones.
The present expertise, under the work-package "Climatic card index" deals with the climatic approach by respect to the design, the choice of materials and building techniques, the bio-climatic devices, the volumes and functional organization of the hammam buildings.
The multi-scale structure of the method will include a sequence of four micro-climates: the whole city site, the close urban area, the thermal passive hammam area and the active one.
The identification of these different micro-climates in the bio-climatic chart will help to characterize each one by respect to the comfort zone and appreciate the opportunity of the forms, proportions, dimensions, building materials and climatic devices designed for each part of the hammam building.
Including a programme of six buildings situated in Cairo, Ankara, Fez, Damascus, Constantine and Gaza, this study will allow to compare the specific designs and devices from a climate point of view.
Introduced by a workshop in Tripoli during the PLEA 2005 in Beirut, the March 2006 meeting and field study in Cairo was the first step towards this process.

Keywords: hammam, climate, micro-climate, building, urban, physiology, materials, volumes, devices, energy water, steam, warmth, bath.

1. INTRODUCTION

The methodology of this study leads to practical proposals through a set of tasks : the first ones after the first meeting in Cairo may help to see a possible future for this kind of building: building survey, thermo-hygrometry survey, bio-climatic study of the collected data, interpretation of the results, diagnosis and some first recommendations.

In the frame of the culturally integrated patrimony restoration leading the programme idea, it is basic and mandatory to ground the process on an approach aware of the health, safety and integrity values inside the building, with a great care with the choice of materials, building techniques, basic physical phenomenon, bio-climatic devices, proportions, dimensions, human physiology and scale.

2. THE HAMMAM BAB EL BAHR IN CAIRO

This building is situated close to the north limit of the old city of Cairo and was built during the Ottoman period, probably during the 19th century, reusing some ancient building elements like columns and capitals. Built at the corner of a handicraft-shopping street (ph. 1) with a connection path, it has been an important neighbourhood pole before the modernization and water supplying of the surrounding housing now equipped with private bathrooms [2].

Beyond the health and sanitary function of the hammam building, the development of social and cultural links between the users could be chances for restoration and a sustainable redevelopment of the neighbourhood.

Photo 1: Sharia Bab el Bahr and hammam entrance at left

The private management of the building and the free studies from the project could also be a chance to help this perspective and make them to meet in a positive and active commitment.

Still operating, the building stands in bad repair without serious maintenance, the structures have been reshaped several times and the steam production machinery has been re-adapted with oil energy and using the urban water supply.

Even under a low quality service and weak modifying solutions, this highly functional building continues to show interesting design qualities which the studies from the recent surveys succeed to demonstrate and support for a next fruitful restoration.

3. STUDY PREMISES

A first approach of the question was implemented at times of the workshop HAMMAM in Tripoli-Lebanon after the 2005 PLEA conference in Beirut.
It was clear that a hammam building may produce the thermal hygrometry conditions of a hot-humid climate, close to 100 % H° in the last rooms.

The preparation of the Cairo kick off meeting in last March was the next step to go further within this question.

Looking at the building by respect to its context, one considered the complete climatic sequence from the city site in upper scales to the steam room inside the hammam so as to understand the global climatic complex.

So as to give large study plans, four main components were delimited (fig. 1):

- the whole city site climate, informed by the classical available data (HMSO in London or others), (climate 1) ;
- the urban micro-climate close to the building and resulting from passive devices : shading, evaporative cooling, air movements, (climate 2) ;

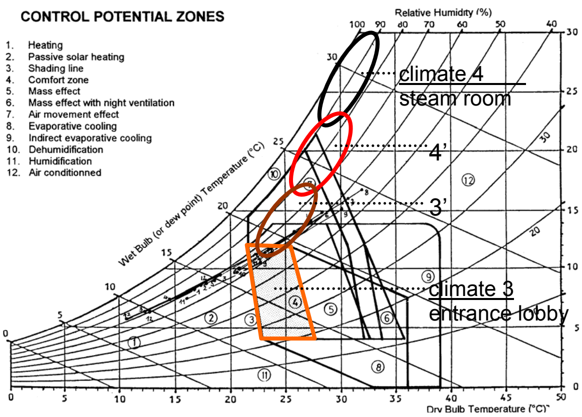

Figure 1: Building bio-climatic chart of Beirut-Tripoli with conjectural hammam micro-climates from climate 3 to climate 4 and two transitional climates 3' and 4'

- the passive area in the hammam, including the large entrance lobby with rest areas and undressing rooms, where several passive devices promote appropriate thermal dynamic phenomena without any active conditioning or heating system (climate 3);
- the active area where the indoor thermal-hydro environment, collaborating with certain passive devices, is mainly managed by machines to produce heat and steam, (climate 4);

Before any thermal-hygrometry measures, it was logically advanced that the climate 3 (entrance lobby of the hammam) might be inside or very close to the comfort zone (fig. 1) all along the year, the extreme seasonal peaks being modified by the work of the passive design and devices.

In the same frame of prospective, it was also advanced that the climate 4 might be situated on the top of the chart, by 100 % H° and a high temperature upper to 30°C.

4. BUILDING SURVEYS

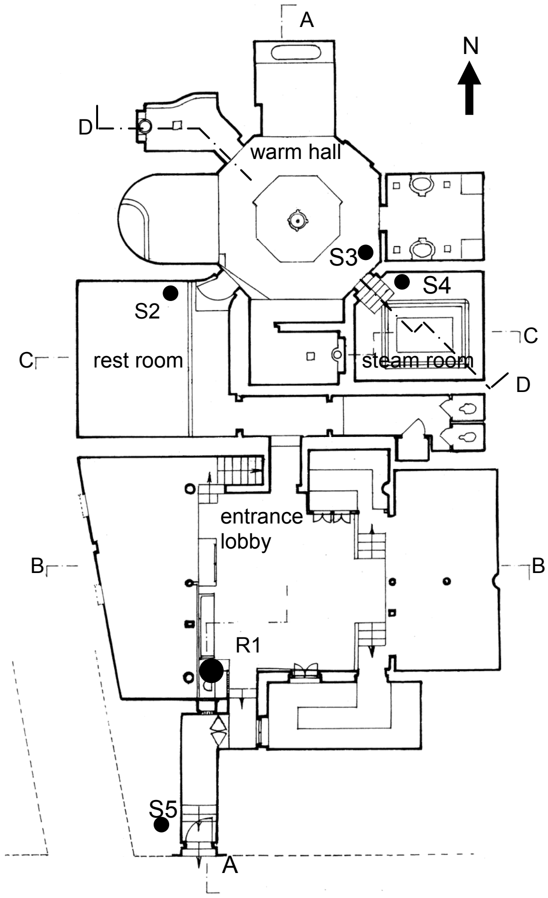

Figure 2 : Plan of Hammam Bab el Bahr in Cairo and 5 sensors positions

The building has been surveyed during the field studies and a short thermal-hygrometry campaign was leaded during 24 hours, adapting the monitoring techniques and statements (average each 2 hours) to the alternative women and men use of the operating hammam building.

The main technical equipment, a thermal-hygrometry cylinder recorder was situated on the desk of the manager's office (R1).

Three basic thermal-hydro sensors were positioned in specific places inside the hammam without contact with the walls and 1.50 up to the floor: inside the rest room (S2), the warm room (S3) and the steam hot room (S4).

A fifth one was put inside the corner shop in the Sharia Bab el Bahr (S5), recording only the minima-maxima T° and H°.

Days	Hours	Data	R1 (climate 3) Entrance lobby	S2 3' Rest room	S3 4' Warm room	S4 (climate 4) Steam room	S5 (climate 2) Street
Wednesday 1st March	6:00 pm	T° H°	22 °C 62 %	25.7°C 72 %	29°C 94 %	33.4°C 95 %	
	7:00 pm	T° H°	23°C 62 %	23.6°C 73 %	29.3°C 97 %	33.9°C 97 %	
	11:00 pm	T° H°	23°C 64 %	23.8°C 84 %	30.3°C 100 %	34.1°C 100 %	
Thursday 2nd March	1:00 am	T° H°	23°C 61 %	24°C 88 %	34°C 100 %	34°C 100 %	
	3:00 am	T° H°	24°C 61 %	23.8°C 87 %	28.9°C 100 %	33.5°C 100 %	
	5:00 am	T° H°	25°C 62 %	24°C 89 %	28.7°C 100 %	33°C 100 %	
	7:00 am	T° H°	25°C 65 %	23°C 85 %	28.4°C 100 %	32.7°C 100 %	17.5°C 57 %
	8:00 am	T° H°	23°C 61 %	23.1°C 81 %	28.4°C 100 %	32.3°C 100 %	
	9:00 am	T° H°	21°C 60 %	23.3°C 79 %	27.5°C 100 %	32.2°C 100 %	
	11:00 am	T° H°	22°C 61 %	23.3°C 81 %	28.6°C 100 %	33°C 100 %	
	5:00 pm	T° H°	22°C 61 %	24.3°C 100 %	28°C 100 %	31.5°C 100 %	25.7°C 38 %
	7:00 pm	T° H°	22°C 60 %	23.1°C 81 %	28.4°C 100 %	31.9°C 100 %	

Table 1 : Statement of T° & H° measures

The statements of the thermal-hydro measures have been put inside the table 1 upwards.

So as to situate the different indoor thermal-hydro environment these results have been gathered inside the building bioclimatic chart [1 & 3] of Cairo (fig. 3) where the comfort and control potential zones and the March climate data of Cairo have been selected.

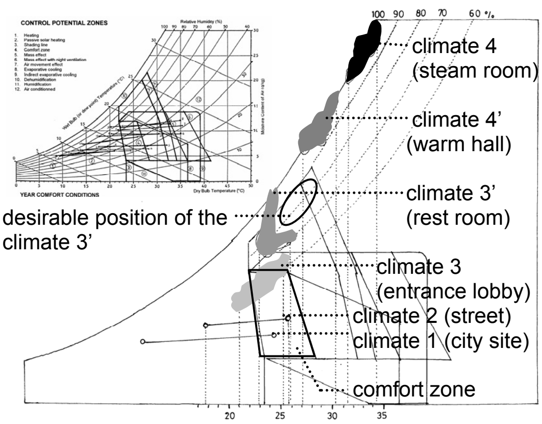

Figure 3: Building bioclimatic chart of Cairo (small one) and Hammam surveyed thermal-hygrometry environment inside the same chart

Several comments can be made from these results: The climate 3 in entrance lobby, is really inside the comfort zone the most of the time (5/9) or very close, as it was advanced (fig. 1).

The climate 4 in the hot steam room is really in the H° limit and between 31°C and 35°C.

The indoor thermal-hydro environment of the rest room (climate 3') is very close to the entrance lobby one (climate 3), compared to a more desirable position (figure3): the temperature is about the same than the lobby one, so too low, and the consequence on the health is negative when people is coming back from the warm hall, there is a real risk to take a cold.

During 24 hours the difference between the climates 4' (warm room) and 3' (rest room) have been °C 3.3, 5.7, 6.5, 10, 5.1, 4.7, 6.4, 4.2, 5.3, 3.7, 4.1, so an average of 5.36°C.

This is the main lack in the sequence; this observation have been confirmed by the users themselves; proposals will be formulated further so as to improve this situation.

The street thermal-hydro environment in March is milder than the city site one: less dry (about -10%), less cold (+ 11°C) and warmer (+ 1.5°C), caused by shading, evaporative cooling (from dust watering) and built masses effect.

Globally speaking, the sequence shows a continuous progression without come back.

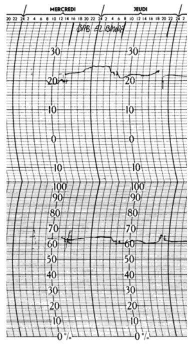

Figure 4: Thermal-hygrometry record in the entrance lobby

The analysis of the thermal-hygrometry recording inside the entrance lobby (fig. 4) reveals an increasing of the warmth and humidity from 7:00 pm to midnight, then a stabilized period till to 6:00 am and a fall till to 10:00 am, a low period with a small peak till to 7:00 pm which closes the cycle.

The curves show clearly that the indoor thermal-hydro environment follows the alternative genders periods and the preference of less excessive conditions for women than for men, but maybe another explanation can also be found in the absence of men for the machines control during the women's time.

5. THE PART OF ARCHITECTURE

The question comes immediately in mind: "What is the part of architecture in these results?"

As described upwards, half of the building including the access corridor, the entrance lobby surrounded by the undressing rooms and the rest areas, works in a passive way without any proper heating or conditioning system; meanwhile, it is real that a small part of the warmth from the warm hall and rest room extends till to the lobby each time somebody opens the door between the two first ones.

A first device is the burying of the building into the ground with 1.50 m depth in the lobby (fig. 5, el) and 1.90 m in the warm hall (fig 5, wh), above the street level.

Rising especially around the volume where the users are sitting, the inertia of the earth mass, combined with the thickness of the wall, maintains the warmth inside the walls of the warm hall as well as it develops radiant cooling in the entrance lobby during summer.

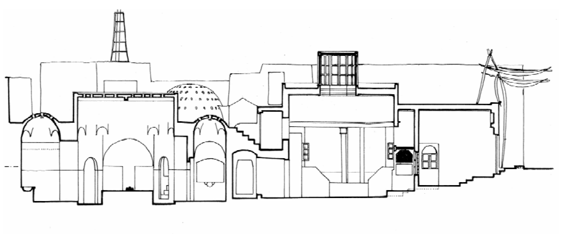

Figure 5: Longitudinal section AA

A second interesting device is the use of the air stratification and the position of the sitting areas up to the general level of certain rooms:

- in the entrance lobby (fig. 6, e.l) the rest areas (fig. 6,r.a) and the undressing rooms (fig. 6,u.r) are situated 0.75 m up to the centre areas: the cooler air remains on the bottom of the room and the spaces around can benefit of milder air layers in winter ;
- in the same space, the ceiling of the centre area is shifted up so as to manage an upper space where the warmth concentrates thanks to the same phenomenon and it is used by the hammam staff to hang the humid towels from the users and to dry them during winter; in summer opening the upper lantern and the door to the terrace promote air movements which dry the towels

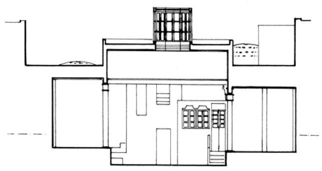

Figure 6: Cross section through the entrance lobby

Even if the heated area of the hammam works by active means, the same passive devices act in the way to save energy: burying in ground, air stratification, high-inertia construction otherwise commanded by the vaulted structural system.

In the steam room (fig. 7) which is situated upper to the warm hall and accessible by stairs, the floor lies 1.47 m up to the hall one: coming from the hot pool buried into the ground, the warmth and the steam evaporate and ascend into the dome volume; as the lower arch of the communication door is only 1.00 meter up to the steam room floor because of the staircase, the warmth and the steam are trapped into the volume and maintained inside; like an inverse bottle, it can extend in the warm room volume only when the dome is full with warmth and steam, but the higher temperatures will always remain inside the steam room because of the stratification of the air.

In upper position, the steam room and the people inside remain in the highest and hottest air layers while the warm hall and the rooms around with their occupants situated lower can enjoy less hot air layers.

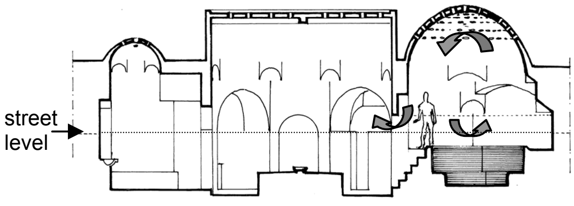

Figure 7: Cross section DD through the steam room and warm hall

The seasonal adaptation of the passive area requires minima manipulation:

During the Egyptian winter, which is only cooler, all the outside openings are closed: the double door system in the entrance corridor, the window of the manager's desk, the door to the terrace and the upper lantern.

The warmth from heated area losses and people's radiation enters inside the walls maintained by the ground burying around and remains in balance.

In summer (fig. 8), the building openings must be closed during the day so as to prevent any outside hot air penetration, except the lantern which will exhaust the residual warmth, in the condition to prevent any sun radiation inside the lobby. Outside in the street, the tissue canopy (e) shades the entrance of the hammam.

During the night, the terrace access door (a), the entrance corridor (b) the window of the manager's desk (c) and the lantern (d) will be open so as to promote a continuous air circulation able to cool the structures and exhaust the warm air outside.

The building structure is mixed mineral and wooden in the passive area:

- stones + lime mortar + pouzzolane lime and multilayer plastering in inferior parts of walls;
- brickwork + pouzzolane lime mortar;
- flat roof on wooden structure and ceiling;

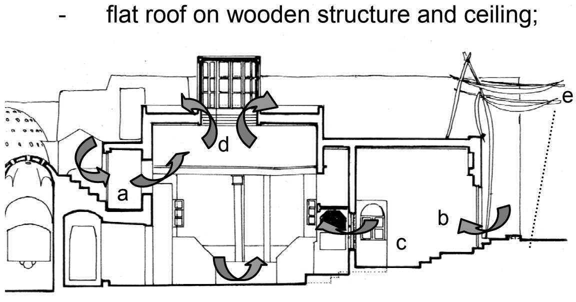

Figure 8: Summer night and ventilation system in the entrance lobby

In the active area, the building structure is mineral:

- same structure of the walls;
- brickwork dome including glass light scuttles with multilayer plastering;

This choice is commanded not only by the negative water influence on the wood, but also by the positive behaviour of the mineral structure in the heated area which can store the warmth and restore it.

Under a dry climate like Cairo one, a long non-operative period can cause important damages due to the desiccation of the structures, so it is very important to maintain a continuous operation and limit the closing periods to Friday and feasts.

6. POSSIBLE IMPROVEMENTS

Some improvements are necessary from a healthy, sanitary and bio-climatic point of view:

- solve the sequence rupture between warm room and rest room: one of the solutions could be to add a door between the access corridor and the rest room; by this way the warmth would not expand to the corridor and lobby and remain inside the room;
- improve the ventilation system: the existing outlets in the rest areas of the lobby and the mouchrabieh of the manager's desk & undressing room;
- restore completely the sanitation system, floors, walls and vaults coverings, plumbing and maintenance system;

Other improvements could be implemented for a better look inside the building (fig. 9):

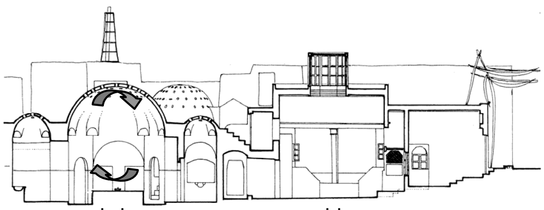

Figure 9: Possible improvements

- changes two wooden beams (wbl) above the rest areas of the lobby and suppress the two poles underpinning the existing broken ones;
- restore the ancient dome above the warm hall (dwh), which will control the anabatic air movements inside the volume ;

7. CONCLUSION

As a specific organization of spaces insuring an efficient and safety sequence of indoor thermal-hygrometry conditions, the short experience and analysis allows express the interest facing a building particularly integrated to the prevailing climate:

- the use of burying to save energy;
- the use of the air stratification to save energy and improve comfort;
- the use of upper openings to promote air circulation in the lobby;
- the clever organization of the inner volumes in the entrance lobby;
- the clever design of the steam room and the communication with the warm room
- the use of heavy stone and brick vaulting to increase the inertia of the building, balance the structural efforts and promote anabatic air movements ;
- the importance to work the hammam without long non-working periods so as to prevent the masonry desiccation and the cracks;
- the use of the flat wooden roof to cover the lobby and limit the overheating in summer;

One can regret disparities:

- the low warmth inside the rest room;
- many alterations of the structures, coverings of floors, walls and vaults, using non-appropriate materials like concrete and certain ceramics producing saltpetre;

The conjunction between the architecture and the indoor space qualities is real, even if the heating machinery produces warmth, the design allows to save energy and to distribute the different micro-climates.

ACKNOLEDGEMENT

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REFERENCES

[1] GIVONI Baruch (1976, 2nd edition), "Man, climate and Architecture", Applied Sciences Publishers LTD

[2] DAVID J-C IFEAD, HUBERT D (1986) "Le dépérissement du hammam dans la ville: le cas d'Alep" in Les cahiers de la recherche architecturale, Espaces et formes de l'Orient arabe, ed. L'EQUERRE VO

[3] SZOKOLAY Steven V. (1986), "Climate analysis based on the psychrometric chart", in International Journal of Ambient Energy, vol 7 nr 4, 171-182