From earth to dome

The construction of a Syrian cupola house

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With the collaboration of :

Fadlallah Dagher, architect
Issa el Khodr, master mason
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To those who are forced to wander the roads of exile
To those who knew how to preserve their values of humanity even in their misfortune
To those who do not retain their knowledge but transmit it generously so that it is carried higher
To the abundance of the poor

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Summary

Transliteration

â, a	أ
b	ب
t	ت
eh, ah	ة
th	ث
g,j	ج
ḥ	ح
kh	خ
ḏ	د
dh	ذ
r	ر
z	ز
s	س
ch	ش
ṣ	ص
ʿa, ʿi	ء

ḍ	ض
ṭ	ط
ẓ	ظ
ᶜa	ع
gh	غ
f	ف
q	ق
k	ك
l	ل
m	م
n	ن
h	ه
u,û, w	و
y, î,w, aï	ي

Introduction

Fadlallah Dagher

A brief history of Dome construction

The first shelter that humanity ever built was probably circular. The primitive groups would have gathered for the night around a fire, enclosed by stones or earth, which protected them from the cold but also from potential predators. Traces of these first houses from the Neolithic era can be found on many sites across the Levant. Surrounded by a circular rubble wall, the Neolithic dwelling was covered with a cone of reeds, thick branches or stubble, depending on the specific location and available resources. Their fragile roofs required regular maintenance, and were sometimes covered with animal skins or dried mud. The first hamlets, villages, towns or cities in the Middle East were founded between 8000 and 5000 BC: Jericho (Palestine), Çatal Huyuk (Anatolia), and Khirokitia, on the island of Cyprus. The latter site is particularly interesting to us with its circular houses: each eight meters in diameter, they had corbelled cupolas made out of mud bricks rising above a rubble base. In the center, a hearth, dug into the ground, was surrounded by stones and the smoke escaped through an opening at the top of the cupola. This particular model has survived through time, and still exists today in the alluvial plains of the Middle East, particularly in the villages of northeastern Syria, along the Euphrates.

Such long standing use of this early model might be surprising. However, the living conditions of the rural populations in remote areas (surviving thanks to the flourishing agriculture) hardly differ from those of the Neolithic era. These settlements used to be built with whatever resources were available: there was clay in abundance but no stone or forests for wood. When kneaded and mixed with straw, clay can be molded into sun-dried solid bricks. These bricks are then used to build the walls. However, the fundamental technical problem for any builder is to cover a space large enough for domestic activities in the absence of large span materials (such as wooden beams). The answer to this problem lies in the invention of the 'Corbelled Cupola': the brick beds are raised on a circular plan with a slight projection (the corbelling) up to the top. Sealed with mud, the bricks form a homogeneous mass where only the vertical load is exerted, carried by the thick walls of the base.

The invention of the cupola began very early in time, at the dawn of the history of Architecture, due to practical and technical reasons, and with no symbolic meaning at that stage. It was contemporary with the first flat wooden roofs, preceding the invention and diffusion of the earliest examples of vaults by the civilizations of Mesopotamia and Egypt. The monumental architecture of these ancient civilizations used flat roofs (made from wood or stone) for temples or palaces. However, the Treasury of Atreus, a Mycenaean buried "tholos" tomb from the fourteenth century BC, is covered with a corbelled cupola of stones, 14 meters in diameter on a circular base.

During the Roman Empire, the cupola stood out as a major element of monumental architecture. The Romans mastered the construction using barrel or groined vaults. The use of Pozzolana, which is the basic material for the "Roman concrete", allowed unprecedented spatial concepts of which the first masterful example is Nero's "Golden House". At the beginning of the second century, under Trajan and Hadrian, the oriental architect Apollodorus of Damascus designed monumental plans using arches and cupolas, culminating in the construction of the Pantheon in Rome, in 125 AD. Built in Roman concrete on a circular plan with a diameter and a height of 43 meters, and crowned by an oculus 9 meters wide, the cupola of the Pantheon symbolizes the cosmos. It still stands today, a testimony to the genius of its builders, combining technical mastery and symbolic evocation. From then on, the cupola was used across a collection of palaces, temples and Roman baths; but although they mastered the construction of the cupolas, the Romans only knew how to build them on a circular base. The early Christian martyriums (San Stefano, Santa Costanza ...) and baptisteries in Rome used the same method, of covering a cupola on a circular plan. Therefore, a new challenge arose for architects: to build a cupola on a square base.

This innovation originated from Persia, with the Sassanians who introduced the squinch, during the third or fourth century AD: a half-cone shaped vault placed at each corner of a square room spanning from the right angle to a broken angle, i.e. from the square to the octagon, getting closer to the circle on which the cupola is built. This specific technology then spread widely through the eastern world and was still in use at the beginning of the 20th century AD.

During the last years of the Roman Empire (around 450 AD) the pendentive was introduced at the mausoleum of Galla Placidia in Ravenna: a spherical triangle rising from the corners of a square room to a circular base supporting the cupola. This process offers a soft visual transition (as opposed to the squinch which forms a dark niche) and it was widely used in Byzantine architecture, starting with Hagia Sophia in Constantinople, built by Anthemius and Isidorus for Justinian between 532 and 537 AD. Erected from cylindrical hollow bricks to reduce its weight, the central cupola is 32 meters in diameter and 55 meters in height; it rests on four pillars, through pendentives. The lateral thrusts of the cupola are balanced in the length of the nave by two half-cupolas of the same diameter, covering an open hall 70 meters long by 32 meters wide without any obstacle, illuminated by a multitude of bays. A series of openings at the base of the cupola gives the impression that it is detached from its supports. As for the Pantheon in Rome, the magnificence of the space is associated with a strong symbolic concept: a square plan transforming into a circle, each one respectively representing the Platonic symbols of the Earth and the Sky. The center of the cupola is occupied by the image of Christ Pantocrator, master of the Universe, and the four pendentives are adorned with the figures of the four evangelists, the pillars of the Christian faith.

From then on, many early Christian places of worship were erected on a central plan topped with a cupola: San Vitale in Ravenna, Saint Sergius and Bacchus in Constantinople, Saint Simeon the Stylite in Syria to name a few.

Islam settled on the Byzantine and Sassanian territories in the 7th century AD. The founding monument of Islamic architecture, the Cupola of the Rock in Jerusalem (705 AD) is imbued with the techniques of the Byzantine builders, with its central plan based on two rotating

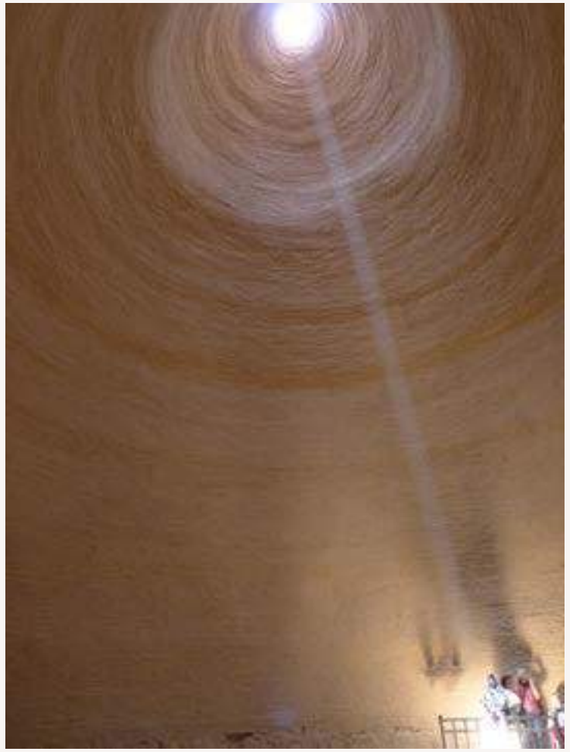
The Pantheon- Rome, 2nd c.AD

Aya Sofia- Constantinople, 6th c.AD

Aya Sofia- Constantinople, 6th c.AD

Friday Mosque- Esfahan, 11c.AD

Mausoleum- Natanz, 14th c.AD



Ice House- Meybod

Selimiye- Edirne, 16th c.AD

Duomo- Florence, 15th c.AD

Saint Peter- Rome, 16th c.AD

squares forming the octagon that carries the cupola. The symbolism of the square (the earth) turning towards the circle (the sky) represents the mythical journey of the Prophet. It establishes a tradition that associates the image of the cupola with Islamic architecture; from the eleventh century onwards, it would blossom into more great achievements such as the Seljuks in Persia and Central Asia became a veritable laboratory for the construction of brick cupolas.

The lack of timber on the Iranian plateau imposes the use of brick vaults and cupolas for all types of buildings, both utilitarian and monumental: dwellings, cisterns, ice houses, caravanserais, public baths, mausoleums or mosques. The Friday Mosque in Isfahan (11th century AD) showcases the multiple possibilities and the technical virtuosity of the Iranian artisans, erecting simple, ribbed, ogival, starred or honeycombed cupolas. To erect the mausoleum of the Ilkhan Oldjeitu at Soltaniyeh (1308 AD), the builders implemented a double-hulled cupola spanning 25 meters, combining lightness and structural stiffness in a technical innovation that precedes Brunelleschi and the Florence Duomo by a century. The introduction of glazed bricks in Persian Islamic architecture further reinforced the symbolic image of the celestial cupola-vault through the use of blue, which decorates the Timurid and Safavid monuments from Samarkand to Isfahan. The upward visual effect is also strengthened by the addition of raised cupolas on scaffoldings crowning the construction, a formal invention that spread all the way from the Taj Mahal in India to Saint-Louis des Invalides in Paris or Saint-Paul in London.

The Ottomans drew inspiration from the Byzantine structures. In the sixteenth century AD, Sinan, the grand master of Ottoman architecture, created luminous spaces covered with cupolas and half-cupolas inspired by Constantinople's Hagia Sophia; his masterpieces include the Suleymaniye mosque in Istanbul and the Selimiye mosque in Edirne.

In Europe, from the begining of the fifteenth century AD, the cupola played a central role in Renaissance architecture. In 1420 AD, Brunelleschi erected the Duomo of Florence without any scaffolding, a technical challenge on an impressive scale: on an octagonal plan 42 meters in diameter, the double-hulled cupola rises 90 meters high, built in herring bone laid bricks, and traversed by a staircase that leads to the summit. There, light penetrates through a large oculus (inspired by the Pantheon in Rome) surmounted by a marble lantern, a structural and formal innovation to introduce light while balancing the lateral thrusts. This major building establishes the technical and aesthetic models of the Renaissance and Post-Renaissance cupolas up until the beginning of the 20th century. Such examples can be seen all the way from the Saint Peter Basilica in Rome to the neo-classical institutional constructions of the New World. With their surprising, unconventional shapes, the complex cupolas of the Baroque era still belong to the same technical school. However little by little, reason starts to prevail over the mystic, and the profane over the sacred. In Palladio's Villa Rotonda (1570 AD), the cupola still evokes the Cosmos, however it is mostly focused around mankind.

Has everything been told? Modern architecture and the technology of reinforced concrete and metal seem to have put an end to the reign of the vault and the cupola. However, the symbolic strength of the form and its mystical evocation of the celestial vault still fascinates many today: the spectacular cupola of the Louvre at Abu Dhabi (2016) for example, appears weightless with its stellar interlacing, filtering light into a multitude of fragments.

The villages of Northern and Eastern Syria still fascinate us with their silhouettes that appear over the plains and steppes of dry and poor regions. Partly destroyed by war and abandonment, the cupola houses in Syria and their traditions are being threatened of becoming extinct. The purpose of the present book is to document and describe the methods of construction through images and words, to help disseminate and perpetuate its multi-millennial technology.

San Carlo Alle Quattro Fontane- Rome, 17th c.AD

Masjid-e-Shah- Esfahan, 17th c.AD

The Louvre- Abu Dhabi, 21st c.AD


SYRIE _ LES MAISONS D'UN RICHE ARABE
VD 10

A cupola house in Lebanon ?

Houda Kassatly

Chapter 1

The genesis of a project: the war in Syria and the interruption of a thousand-year old tradition

In 2011, Karin Puett and myself were interested in the cupola houses located in the North of Syria. At the time, we published a book on the subject however, not in our wildest dreams did we imagine we were only a few months away from the beginning of a long conflict.

In March 2018, I returned to Aleppo on a mission within the UNESCO framework. The trip incidentally allowed me to assess the condition of these houses in person as the taxi and bus routes between Aleppo and Beirut had been altered during the war. As one could only venture along certain sections of the Damascus Aleppo international road, the drivers were forced to make detours and find new routes. These new routes traversed through regions which lay host cupola houses, such as the villages of Khanaser, Al Safira and Lake Jabbùl. Raw images of deserted places and ghost-like villages that eight years of frightful conflict had left in a state of extreme deliquescence, had replaced the vision of these formerly cheerful, joyous and colourful towns. Bombings induced the first wave of destruction, which led to the departure of all the inhabitants and this then engendered a second and fundamental collapse: the forced departure of the inhabitants, whom by fleeing a country slaughtered by war, magnified the cohort of refugees seeking asylum in the surrounding regions and further afield.[1] This departure's corollary, namely the absence of the necessary maintenance for the preservation of the cupola houses, almost annihilated their existence.[2] As the conflict persisted, these abandoned dwellings, deprived of the vital forces essential for their preservation, have now disintegrated. Where most have collapsed entirely and only exist now in their original raw materials, some still have a chance to be restored. This not only shows that the war destroyed numerous sites and ancient places, but also, it had violent repercussions on the habitat and architectural savoir faire. While the shortage of specialized master masons had already jeopardized the future of these houses long before the conflict, their construction had persisted over thousands of years, as corroborated by various archaeological excavations.

These observations highlighted the urgent need to establish a policy to preserve the unique construction techniques, especially because, as in any post war era, international funds are usually allocated to the restoration of large scale monuments in urban areas, repairing damaged ancient cities, and to the renovation of various UNESCO World Heritage archaeological sites. Safeguarding these projects is, without a doubt, an urgent matter. However, we also must not underestimate the threats inflicted on this heritage, namely the countless traditional skilled craftsmen and their local construction techniques. It would be so unfortunate if no proper attention was paid to the cupola houses which constitute such an important part of this heritage

1. H. KASSATLY, K. PUETT, *De terre et de lumière*, 2011, Éditions Al-Ayn.
2. This region had become a fighting field for the belligerent parties and acquired the status of a military zone. It's access was forbidden.

An inevitable relocation

It is precisely through the arousal of little interest in the vernacular and rural architectures and forgotten industry in reconstruction projects, that we decided to set up a construction site for a cupola house. We intended to document and record the knowledge related to this technique to preserve it before it permanently disappeared in the immense turmoil of conflict.

A time sensitive response was therefore critical. Ideally, the experience should have taken place on Syrian soil, with the construction erected in situ. However, because of the war and other obvious security reasons, the idea of achieving this plan on site was severely hindered. Consequently, we resolved to delocalize the extra muros construction, despite the complications this relocation would eventually generate.

It is therefore in Lebanon, specifically in the *arcenciel* center of Taanayel in the Bekaa, that we set up our construction site. By the end of October 2018, a house topped by two corbelled cupolas was born. It was built with the help of masons and master masons from Syria. Following the site work, we have decided to write this manual and include a technical part clearly explaining the construction process. This can then be shared with any person or group wishing to recreate a similar experience in the future.

In a way, this project promoted a facet of the local Syrian popular culture which was about to be lost entirely in amongst so many other priorities. The houses' former inhabitants, who were directly affected, now have many other preoccupations and are mainly concerned with problems relating to their daily survival. However, thanks to the British Council's cultural fund, we were able to allocate sufficient time and interest to the implementation of this protection and valorization work. By undertaking this work, we emphasized that, despite dire conditions in which young Syrians live today, especially those exiled and increasingly foreign to their own culture, demolishing their sense of belonging and cultural heritage is unacceptable. This heritage is not only composed of great works, but also of simpler trades, techniques, and know hows that are an integral part of the cultural heritage of humanity.

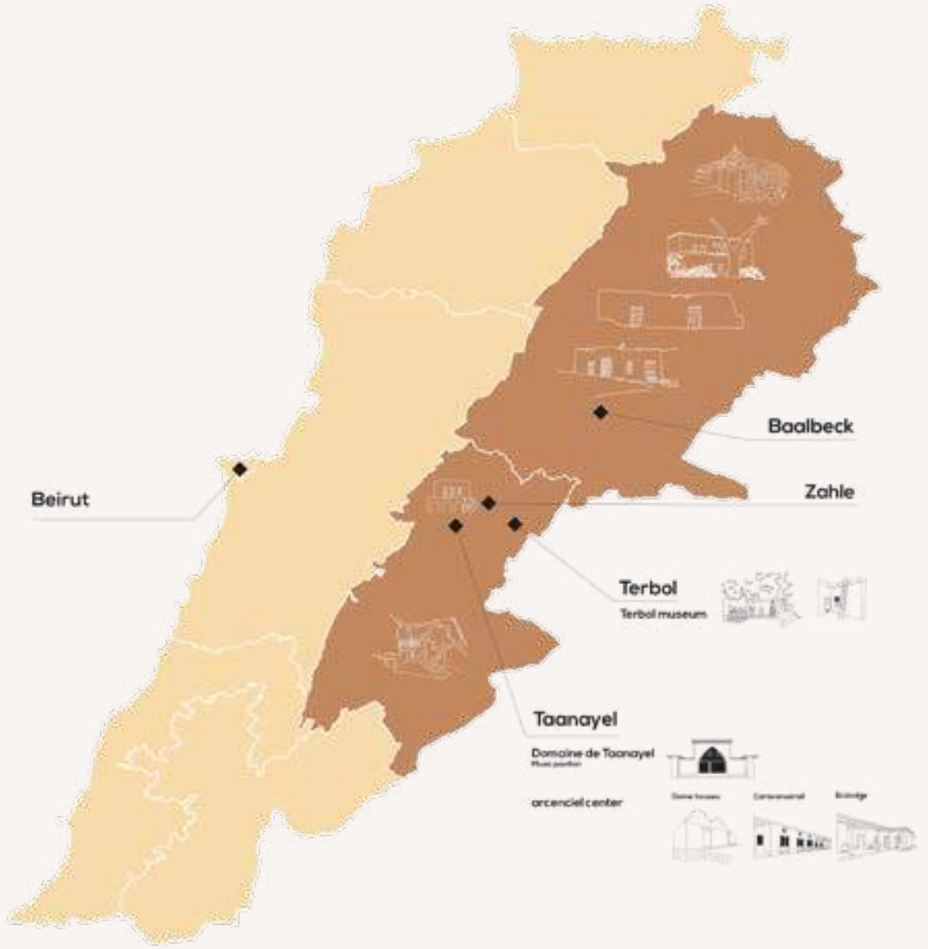
Chapter 2

arcenciel, a place to experiment with earthen architecture

This map represents Lebanon and the mohafazat of the Bekaa, a historical region known for its mud-brick architecture. In the lowland, the construction techniques used only clay whereas in the mountainous regions, bordering the plain, a mixture of stone and clay was used, for extra strength as there is a high risk of snowfall.

Furthermore, it presents the recent implementations achieved by using those techniques, and provided by the National Foundation of Heritage (Museum of Terbol, 2004) and *arcenciel*, in its center in the Bekaa (ecolodge, caravanserai, cupola houses) and in the domain of the Jesuit Fathers (bandstand).

It must be mentioned that many more projects of restoration and construction in raw earth have been conducted in the region, although they were not added in on the map.



Led by *arcenciel*, the project of building a replica cupola house could not have found a more suitable location than Taanayel (*arcenciel* center and the Jesuit Fathers' domain) since the space already hosts several muds brick constructions.

In the 2000s, *arcenciel* initiated a project to promote architecture that had been extensively devaluated and weakened half a century earlier. In 2005, when the association first built an ecolodge consisting of 5 mud-brick houses, no one envisioned that this first construction would lead to the caravanserai (in 2009) and the bandstand (in 2017) which stemmed from fruitful collaborations between several local and international architects.

Thus, the Syria cupola house now found at Taanayel exists in a very privileged setting, one that we have high hopes to extend in the future. It feels like a natural fit to have the cupola there, and now the whole site has transformed from a modest adventure into a very successful sustainability program, and experimental laboratory destined to enrich itself further in the years to come.

It was hard to imagine early on, that the rebirth of such projects would transform into a permanent construction site. One project led to another, and each time we were presented with new challenges and innovations to design and implement.

Transmission, however, remains the key word for *arcenciel*. This is what the association ensured by sponsoring these projects. Accordingly, workshops, trainings and publications (including construction manuals) were set to safeguard local knowledge and to contribute to the eventual reproduction of these empirical experiences.

Chapter 3

Methodological overview and history of an experiment

Ethnographic work

Since the implementation of the ecolodge in 2005, *arcenciel* has created a specific approach to understand vernacular construction. The publication of an ethnographic handbook always precedes the setup of the construction site. It lists and describes the house types, the functions of the various elements inside and the individual functions of the house's annexes: wells, silos, and henhouses, among others. This vast collection of materials documents and illustrates what exists and can be used to promote the sight. The profusion of images incorporates a storyline which, during the second phase - namely at the time of the establishment of the construction site - embodies an indispensable reference source. It suggests inspiring models and essential indications. Therefore, this stage of ethnographic collection and research is a critical phase to guide masons who are frequently unfamiliar with this habitat. It makes it possible to restore their lost memory and reestablish strong connections to their grandparents' building techniques, from which they have become estranged.

Some photographs were of great value assisting the masons during execution. The images, by restoring the missing link, somehow compensate for the absence of those who mastered the knowledge. Within the pages of these documents lie answers to questions that would have remained unknown and impossible to answer as the concerned persons are no longer here to provide a response. By normal evolution, the transmission of these techniques to new generations would have been conducted either through direct learning, or acquired by mimicry and observation. On our site for instance, the photograph of an arc stripped of its coating layer allowed the mason to understand in more depth, the construction techniques.

Such work constitutes the very first step towards the revaluation of this architecture. It emphasizes the importance of this construction and creates renewed awareness of these houses former inhabitants who no longer view it as a viable construction option suited for their needs.

Fieldwork and interviews

We could not proceed with implementing the project until the key preparatory phase was complete, which involved conducting many detailed interviews and field surveys. Both instances allowed us to gather as much accurate information as possible about this architecture from the relevant persons. In this collection process the interviews played a pivotal role to overcome the lack of technical information in the earlier mentioned ethnographic book. This information later proved to be indispensable for both the construction work and the writing of this manual.

With the on-going war in Syria, visiting the deserted regions where cupola architecture still exists was impossible. However, in a twist of fate for our informers, displaced by war, who had unwillingly found themselves at the very place where the project was being relocated, in Lebanon. The influx of more than one million Syrian refugees to Lebanon, a number of whom came from villages with cupola houses, offered us a rare opportunity to carry out a thorough investigation in the country where they sought refuge.

It was in the Syrian refugee camps in Lebanon, where occupants are grouped by family and geographical origin, that we searched for people who had once lived more or less permanently surrounded by this type of architecture. There were those who, before the conflict, lived in cupola houses themselves, those who were familiar with them because they were the homes of their parents or grandparents and, finally, the very few who had witnessed the building of such houses. The scarcity of people who had ever participated in building a cupola house was not surprising since, aside from isolated projects in Tell Abiad or Salamieh, very few such houses have been erected in the last fifty years.

Interviews were conducted with the few men and women who were fully involved in the construction process. It turned out the tasks were assigned based on gender. Men were tasked with the heavier works such as brick-making and the construction itself. Women tackled lighter tasks such as finishing, laying of coating, and decorations. However, certain constraints sometimes blurred the boundaries of this distribution of labor. Women would sometimes get involved in making bricks, or other masculine work, while men would engage in women's chores. Although a number of male interviewees firmly voiced their refusal, their indignation, and even their shame to defy the social standards, claiming it was "unthinkable", "frowned upon", and "not our job", our conversations revealed that the rules were not always strictly respected.

Above all, in the absence of men, often gone to seek other sources of income, roles were reversed, and tasks became asexual. Within this context, the following is an eloquent testimony: The coating of the top of the cupolas, considered as a dangerous enterprise, has always been a man's task. Ironically, in the region of Hader near Khanasser, where the highest cupolas could sometimes reach six meters high or more, men were too afraid to climb up so high. Their work was then given to the one person who could carry it out, and it was a woman.

While these discussions broadened our discourse, they also allowed us to ponder more realistically the future of these dwellings with cupolas and to question if they still held a legitimate place in the Syrian landscape rather than subsist solely as a vestige of the cultural heritage.

Building the team: a reverse lesson

The interviews facilitated the collection of knowledge, yet their goal was also to identify a builder, who had experience in the required architectural techniques. While the importance of collecting information is unquestionable, some of the associated techniques, related to specific construction phases, were destined to remain incomplete in the absence of a master mason specialized in cupola houses. This lack of expertise exposed a heightened risk to the project since our experience was limited to less complex earthen and flat roof houses erected during our previous projects.

The quest for finding the right person proved to be complex, as the transmission channel had been broken for far too long for this research to be possible, even in Syria.

Once again, it was in the Syrian camps in Lebanon, that after intense research, we identified the person who seemed most adequate, because of his very contextual and accurate discourse. After this crucial step, we dedicated ourselves to building the team. We relied on a group of workers who were already involved in our other projects, and familiar with the earthen construction techniques. Many camp workers joined this group further down the line.

Our previous experience in building proved that succeeding on a construction site required the cohesion of the team by welding everyone on the project, together. We organized an awareness session revolving around the values of *arcenciel* and the consolidation of efforts to achieve a common goal. We explained the mission of the cultural program encompassing the project and the challenges in terms of protecting the region's cultural heritage. These sessions were followed by meetings with the lead architect, Fadlallah Dagher. Fadlallah drew perspective plans and cross-sections based on photographs of cupola houses. He also put up a layout plan for the construction, based on space availability and the possibility of integrating it into the existing building. These documents allowed the calculation of the required quantity of bricks. They were further discussed with the team of masons who brought further clarifications about the dimensions of the space. An amended drawing was then sketched out on the spot in order to settle on the final dimensions, especially for the starting levels of the corner pendants (tha'lab) and the edification of the cupolas.

Early on, Fadlallah Dagher and I agreed to stand aside while the master mason and his team handled the project. Once the guidelines were established, the masons started to build the walls. They then laid out pieces of wood breaking the walls' angles at the height of 80 cm and began to erect the pendants and cupolas. The architect observed the process from a distance, only intervening to highlight minor details.

By granting them the flexibility to decide the measurements themselves and to work as they are used to, the masons followed their own procedures. During this phase of experimentation, we could not position ourselves as holders of knowledge we did not possess. It became necessary to invert this architecture "lesson", transmuting ourselves into observers. We became novices, apprentices, workers, students, receptacles of a know how from the field, able to follow the method and initiatives of the builders. By following in their footsteps, we learned from their contributions and practices[31].

Once this lesson was learned, we felt that our margin of intervention had allowed us to capitalize on the knowledge these people held. Though we are not eligible to call this know how our own, we feel nonetheless entitled to be the emissaries, the heralds and the keepers of this legacy. This is our place, the one we claim, the one that years of fieldwork taught us to assume.

3. Although we discovered later that the master mason we hired was not up to the task, it is nonetheless true it is mainly from the field that we gathered knowledge. The rest of the team took over to boost the project.

Young refugees, young builders

Several young boys tagged along at our construction site. By European standards, they were not yet of the legal working age. By hiring them, however, we simply respected the construction traditions of Syria where members of a group, adults and children, all take part in building a house together, each working to their own capacities. The younger ones ferried materials to the job site and the older ones assisted the master mason. The construction of a house is above all a collective work that sets in motion interfamilial and neighbourhood solidarities. The presence of young boys and girls at different stages (including the application of plaster, an eminently playful moment) played an important role in familiarizing them with local techniques. Thanks to this participation, although generally passive, some adult masons who worked on the site managed to recollect lost techniques and gestures imprinted in their visual memory, as they had first witnessed these constructions when they were kids.

Therefore, it made sense that the youngest of them were present on and around our site. However, this integration did not imply they were enthused about our project from the very start. When asked what they thought of this architecture, a frank and realistic response, touched with cynicism, was given by one mason: "They are refugees, so they know that, if they want to eat, they have to work." Prosaically, for these young people, some of whom are the only breadwinners in their families, the stake was exclusively economic. Building a mud house or a cement house meant a day of labour ending with a paycheck, vital for the survival of their loved ones. This explains why they did not initially gage the stake of the project, nor shared our enthusiasm for a construction they did not even recognize anymore, since they had taken the path of exile from an early age.

Nonetheless, several factors changed their attitudes toward their work, including the participation of young university students who came to the site for training purposes and the presence of visitors from various backgrounds, as well as the preservation, through the photographs of separate stages of the construction development. The fact that these young refugees were building, in a host country (one not always welcoming, where they are discriminated against and where they struggle in their everyday lives), a house that is part of their cultural heritage and recognized as such by others, gave them a huge sense of pride. In this particular case, ensuring their survival resulted in a project that intimately linked them to this legacy beyond the essential livelihood. This explains how, while only being in charge of a basic job, some of them invested more time in the construction by experimenting with innovative steps, thus acquiring the expertise of adults. Beyond the success of the actual construction, the goal of promoting this architecture was achieved by allowing the young to understand that they have, in their own way, contributed to the safeguarding of this architectural technique, whilst partaking in this unprecedented experience. The pride of being a core element in this adventure was summarized by one of them: "Every year, I will be in a book."

« A construction site is by its temporary and unfinished character a metaphor even of what can be possible for man »

The Art of The Building. Site Construction and Demolition from the 16th to the 21st Century from November 9, 2018 to March 11, 2019, Architecture and Heritage City.

History of a building site

The cupola house construction site took place in the center of Taanayel in the Bekaa valley, from May to November 2018. It allowed the people involved to reconnect with this construction technique despite the fact that the learning path was sown with pitfalls.

Originally, we had to confront the difficulties that emerged from our decision to relocate the site to Lebanon. By building away from the very place of birth of this type of habitat, we were cut off from the natural geographical environment, and consequently exposed to divergent climates and materials. The resources that would have been in our reach would have allowed us to test, much more easily, the validity of our construction. It is why this site, just like any other site, was indeed a place of experimentation where trial and error, tests and dead ends occurred and therefore pushed us to opt for other paths and to find alternative solutions on the spot. The process was never linear, instead, it required innovation; it coerced a constant reconfiguration, changing decisions along the way to adapt to unexpected issues, resulting in always having to find a plan B.

Our master mason's failure to rise to the challenge was also a significant turning point. We had attempted to solve the question of the human element by forming a team of Syrian workers from regions that hosted this specific architectural technique. However, there was no guarantee that this would be a wise choice. Our fears were confirmed as the master mason was obviously not up to the task, we had entrusted him with. He probably had repaired some cupola houses and was capable of building the bases of the houses however he had definitely not constructed arches and cupolas. As a refugee facing economic imperatives, he pretended to possess skills he did not have in order to get the job at any cost. Despite his efforts to hide his lack of experience, the construction site demanded complexities that he could not keep up with. We faced a dead end. This major difficulty induced a shift in the course of the construction. As we debated a new policy to adopt and I had nearly surrendered to dismay, one mason suddenly pledged to take over: "We will build this cupola, relying on your book and my childhood memories. From now on, I no longer wish to get paid." This man, a Syrian war refugee, although diminished by his exile status, was ready to attempt the experiment, putting aside any financial consideration despite its obvious importance. Thanks to the interviews conducted, the books published on the subject, and above all, the team's undivided efforts to dive back into the depths of history and memories, the project was salvaged and eventually completed.

However, the obstacles did not stop there, and the project continued to be riddled with further issues: the refugee workers' conditions were difficult, with their daily life altered from war, the relocation and the objective of producing a replica of a millenary construction with limited means. Yet, it was finally accomplished because of the masons' concern for the ultimate goal. These refugees saw this project not only as a construction process per se, but also as a chance to reconstruct themselves. The words of one of them summarize the process very well: "It isn't the money that counts, it's the personal connections." He was not a trained mason, but a civil servant before the war in Syria. His desire was to win back his self esteem, which the project did for him. In parallel, for some of these refugees, men and women, who stood by us during this experience, passing through the building site was the path to restoring lost dignity. Anonymous workers, and hardworking men, have now become valued trainers, carriers of these know hows and transmitters of this culture.

All experiences are filled with facts, words and gestures that stretch beyond the success and technical prowess. This project, as difficult and as complex as it was, revealed solidarity between

people from diverse horizons. Beyond any practical and material enterprise, the construction of the cupola house took on an unprecedented dimension illustrated by this moment: on the last day, a young architect, equipped with her cello, entered the cupola house which had just been completed to play a small score. The builders, sensing the solemnity of the moment, silently took their place beside her, thereby sealing the success of the project and the communion in this incredibly unusual construction site. The rite marking the completion of a construction site usually consists of the immolation of an animal in the region, however, for practical reasons, this was moved to another date. This small unexpected gesture marked the birth of a common work. An architectural act born of constant exchanges, a convergence of experiences, knowledge and the goodwill of all participants: architects, masons, teachers, students, Lebanese or Syrians, who installed far more than just a construction; it was a creation.

The documentation

It is undoubtedly due to the importance of the challenge and the difficulty in achieving this project that we wished - as we did for all previous projects - to document the stages and evolution with images, videos and drawings. The ultimate goal was to make future projects easier. Clearly aware that a site is never at a standstill and that each and every one has their own story to tell, we wanted to document – as much as possible – the milestones of a general construction guideline to facilitate any other future executions.

The goal is to help people, who wish to repeat this experience, by sparing them the trials and errors, the uncertainties, and the doubts we encountered. We have tried to pave the way for them in the future. Above all, we hope to empower them to produce a house at a much lower price. Indeed, any delay on a construction site incurs additional costs. If this habitat is to compete with other construction techniques, it is vital to ensure its construction cost is competitive as well, because it is a strong argument for its revaluation.

To complete our goal, it was essential to document (or record) in the clearest way possible the knowledge produced onsite. This is the purpose of publishing this construction manual. It allows us to record acquired knowledge and the empirical experiments carried out, with all the successes as well as the failures.

Chapter 4

The trainings

A construction site gives a rare opportunity to learn and train in the field. Particularly with this type of architecture, having been almost completely left behind since the 50's and with many similar sites having gradually disappeared. Historically speaking, the few earthen constructions that have taken place lately were set up within the framework of projects aiming at valorizing this type of architecture[4], whether done by *arcenciel* or elsewhere, and were followed by a few low key projects of renovation.

Onsite learning for students specializing in architecture or heritage (or other disciplines interested in eco sourced constructions) allows direct transmissions of knowledge. Moving from a strictly theoretical knowledge to a practical training on site, including both observation and active participation, grants all interested persons the opportunity to understand the field's reality. With the construction site comes the possibility of interaction and innovative exchange between students and the whole team of workers, led by master masons, inheritors of this thousand year old knowledge. Partaking in such sites cannot but enhance university teachings with an empirical knowledge like no other.

While the importance of these trainings is unanimously acknowledged, it can still sometimes collide with the high costs that results from setting up construction sites specifically intended for training. This is why the importance of a project such as the construction of a cupola house is critical. We therefore seized this opportunity to make these courses open to as many people as possible and to various target groups. In this prospect, while aiming to teach forgotten techniques and spread awareness, we organized several workshops divided into themes, according to the main phases involved in earthen construction: manufacturing of mud bricks, construction, floor levelling, and finally coating.

4. Such as, for instance, the renovation of Rami house in the village of Terbol in before turning it into an eco museum, as well as the renovation of a house in Zahle as well as in other locations.

The success we encountered was so big that extra workshops had to be added in the process. We chose to keep our doors open and not turn down any of the many requests we received, even the most unexpected ones. A very diverse public, including a wide range of nationalities (Lebanese, Syrian, Palestinian, French, Canadian, British...), of various age groups and profiles, spontaneously came along. We were then able to reach a bigger audience: from groups of Lebanese on vacation, to tourists, to foreign scouts on a mission to Lebanon, even to young Lebanese expats, some of whom had little to no knowledge of Lebanon. Our workshops allowed them to dive into the region and to earthen architecture, which most participants had previously ignored its very existence. Even for those who were not even remotely familiar with this type of construction (having different areas of expertise), partaking in workshops and learning the techniques enabled them to become more aware of the advantages of earthen architecture at a time in history where environmental challenges critically affect and concern us all.

However, it remains clear that our main target group was young students majoring in architecture or renovation. As soon as we sent out calls for participation, we noted with considerable astonishment the amount of unexpected responses we got from large numbers of young university students who hurried to our site and did not miss any of our workshops. This unprecedented enthusiasm allowed us to measure the change that had occurred since we published our first book "Dwellings in the Bekaa, design of rural housing on the Lebanese plateau." (Original title in French : "Terres de Bekaa, l'aménagement rural sur le haut plateau libanais"). Back then, the interest was limited, to say the least. More than 18 years later, this palpable passion manifested in young students reveals a very noticeable change in trend. It is without a doubt, that the local education and teachings take into account the parallel path of the traditional earthen architecture that presents advantages not to be neglected in a time when natural resources are vanishing. The interest in these workshops reflects a tendency to reconsider the contributions of the past, to appreciate the means to reconnect

with this heritage, and to rethink it through innovation and major environmental concerns.

Overall, the importance of the workshops that captured the attention of a new audience curious about earthen architecture is that it gathered a variety of participants from engineers to architects, architects specialized in the renovation of built heritage, masons (bricklayers), and entrepreneurs. Some students had already been working on earthen renovation projects while others were simply curious about the architectural traditions in Lebanon and specifically in the earthen architecture of the Bekaa. The spectrum ranged from knowledgeable teachers who encouraged their students to enroll in these workshops to freshly graduated architects.

Another positive factor is that the project has hosted Lebanese as well as young Syrian refugees in the Bekaa, where they sometimes have trouble coexisting. In a way, the project helped change a number of misconceptions thanks to the participant's collaboration. The work was done through mixing very different groups: workers who were not used to working alongside the directives of their project's sponsors - and who have been promoted to well informed and experienced trainers - and young or not so young recruits wishing to gain a newfound experience. The cohesion between the different groups and the closeness among all participants were obvious throughout all workshops.

The pedagogical significance of such workshops, which ultimately welcomed more than a hundred participants, is no longer in need of proof. The determination displayed by young participants – as bearers of this architecture – stresses the necessity to keep implementing similar projects, so that other generations are also able to experience on site the various techniques of this type of construction.

Method of construction of a domed house

Houda Kassatly and Issa el Khodr

Chapter 1

Workers, tools, and tooling

Maᶜmâr, maᶜmârî, maᶜmarjî or *bannâʼ* are the words by which a builder is designated. The master mason is referred to as *muaᶜllem* de *ᶜilm*, or more precisely *muaᶜllem ᶜamâr*. The generic term *muaᶜllem* is attributed to the person who has the specific know-how of the profession and all of its inner workings. He is the specialist, who directs the workers, *ᶜummâl*, and guides his team of labourers, *chaghghîleh*. Furthermore, according to a dictionary definition of the profession, le *muaᶜllem* is above all, the inspirer to do what is good and what is right.

Collective cooperation

In the villages of Syria, construction was done with reciprocated assistance and collective cooperation. As soon as someone expressed the desire to build a house, parents, neighbours and friends extended their assistance to help dig foundations, transport materials, erect walls and so on. This system was both economically and socially viable. Economically, as it was both cost and time efficient; and socially, as it formed the basis of a loyalty system where this exchange of aid and services, forged strong bonds between the members of the community. It created an idea that a person who needs help today should be willing to lend a hand tomorrow.

This solidarity from the start of construction is just one example of the collaboration expressed within the social life of a group; inhabitants show their solidarity at all times, offering their sympathies in difficult times but also lending their support in happier times too. Aida Kanafani's description of the collaboration during the preparation of food reserves is based on the same principle as the money loaned where the assistance becomes a form of debt: "The woman receiving help does not 'give' anything in return, for she believes she will lend a helping hand to her receiver when the time is right »[5]. This collaboration in underprivileged societies where people support each other explains the emergence of the filiation of milk, tracing back to when women who lacked breast milk entrusted a relative, a friend, or a neighbour with their infant to feed him or her. Women not only ensured their child's survival, but also established a network of affinity by breastfeeding with its coded rules of filiation. The neighbours are bound to help each other; it is a proverb mirroring a practice where everyone has a role to play, allowing them to confront any shortage. This principle is also applied in construction, where the whole community gets involved, from the youngest to the oldest, each offering help according to their abilities.

The master mason was the only person working on the construction site who was foreign to the local community[6], In order to guarantee the success of the construction of the cupolas, the villagers had to call in a specialist. They secured his lodging on site for the duration of the construction, typically 15 to 20 days after the manufacture of the bricks, to spare him the daily commute. Due to the lack of public housing in the Syrian countryside, the master mason was lodged either in a tent, since the community was often nomadic or in the house of the owner or one of his relatives (provided they had one) or neighbour's. The master mason and his team of workers would then share meals altogether, with the labourers and their families too.

5. A. KANAFANI-ZAHAR, *Mune : La conservation alimentaire traditionnelle au Liban*, 1994, Éditions de la Maison des sciences de l'homme, p. 219.
6. Usually, only one master mason works on a construction site.

Tools and tooling

The tooling used for the construction of a mud house was basic and manual. There was not an abundance of tools however some were more readily available than others, for example spades and shovels which were already used by the builder-peasants in their agricultural work.

Generally speaking, the builders worked with whatever tools were available to them. Due to this, the choice of tools constantly evolved and new tools always surfaced. For instance, the oil level, *zaïbaq*, replaced the plumb line, the sponge replaced the jute and the trowel replaced the human hand. Later, with access to the electric grids, electric tools such as the drill, saw and jointer were introduced to help facilitate the work with wood and electrical installations.

The function of a tool is never irreversible but constantly adapting to the needs

The function of some tools may vary during construction. For example, a wheelbarrow can be transformed into a container for mixing mortar or plaster and a barrel, into a receptacle to mix water and a small amount of earth. Adaptation, innovation and inventiveness remain the keywords on any building site. It is certain that, as the work progresses, and new needs surface, the workers learn to manage with what limited means they have at their disposal. Since they themselves and the generations before them, had become accustomed to working in scarce environments, often in distant and remote regions and in times where tools were rare and precious. However still, they always know how to make the most of what they have, adapting to the circumstances. Consequently nothing is wasted, a useless plastic container can be cut transversely in two to serve as a second bucket; discarded wood slates are used to make the frame of a large sieve; bricks are laid one on top of the other to facilitate a passage; the bags used to transport materials are also used as carpets keep these materials separate from the soil when preparing a small mixture; useless plastic bags also serve as head covers to protect against the flow of the *ḥuwwâra* whilst laying the finishing plaster. At any given time, they demonstrate their

inventiveness to ensure a fast work pace and progress. They often quote proverbs such as «Necessity generates the trick », "Necessity is the mother of invention", and remain faithful to those proverbs on the building site, applying them constantly, showing ingenuity and creativity to find immediate solutions to problems they face, to try and avoid any delays to the work. In some cases, if something is unable to be sourced in Lebanon like the *meche*ᶜ, a smoothing instrument used specifically for the laying of sealants and the finishing plaster on the cupolas built in Syria, a master mason canmake one on the spot.

However, each time the builder finds a new tool that facilitates his task, he adopts it. It is therefore likely that inventions such as the BTC (Blocs de Terre Crue), manual or an automatic press, which are used in several continents because of the great speed that they produce storable bricks at, are used by manufacturers, if they are available.

Typology of tools

Tools for handling and transportation

For the constant handling of the mixture and mud bricks on the site, workers mainly use wheelbarrows and baskets.

The wheelbarrow allows them to bring the bricks, mortar, and the coating, as close to the point of construction as possible. Whilst standing on the scaffolding, they transport the mixture and the coating into a recycled resin basket, (known as, *zanbîl*, in Syria), called *quffat in Lebanon*.

To move the bricks during the construction of the cupola, when the walls become too high for a standing man to reach, several workers gather (three or four depending on the height of the cupola), to form a sort of a chain. The person standing closest to where the bricks are stored or next to the wheelbarrow, passes the brick to the person standing on the wall or on the edge of the cupola, *tyâkh*. The latter passes it, in turn, to another worker and so on, until it reaches the hands of the builder. Very often, instead of passing it on, they throw it. To avoid slowing down the pace, the team is on high alert to ensure all the *mouᶜallem* needs are met. As soon as the master mason has prepared the next placement, a new brick must be laid down without any delay. The presence of a large number of workers prevents any lags. In general, young boys prepare the mixture at dawn and dedicate the rest of their day to the transportation of the mixture and bricks.

Although the bricks are very heavy (one brick weighs between 13 and 14 kg), the young workers move with surprising agility and disconcerting dexterity, giving the impression that their gestures do not require much effort but it is the contrary.

When it comes to the conveyance of liquid, mainly water and finishing liquid plaster, they use a bucket, *dalû* or *satl*, made of metal. It is similar to a bucket that was used to retrieve water from a well before running water was available, however now it is used to provide water to the workers during the laying of the finishing plaster. If a bucket is not available, a basin made of iron or aluminum, *tochot*, can also be used. A "packed" bowl is used to splash the liquids; any other container, for example a plate, can also be used to supply the workers with small amounts of plaster.

Various tools

Shovel

The shovel, *rafech,* is used mainly to blend the mixture and fill the wheelbarrow, but also to pour the mortar over the walls when the height of the wall is still within reach of the builder.

Sieve

Used at several stages of the construction and in various sizes, sieves, *ghourbâl,* were formerly made by gypsies who went from village to village, selling them to the farmers. They were made from a wooden frame and organic mesh, normally made from goat's skin, known for its resilience. The future use of the sieve dictated the distance between the meshes.

Nowadays, the sieves are acquired from specialized sellers and are made from a metal or nylon mesh which corrodes less easily.

Gloves

At all stages of a house construction, from the manufacturing of bricks to the laying of the finishing plaster, builders always work with their bare hands. In order to make it easier and to protect themselves, they adapt the trowel and wear gloves whenever they could. However often they remove the gloves as they prefer using their hands, as if it is the only way they can achieve an optimal result.

The scaffolding

In the past, the builders never used scaffolding, they relied on the manual handling of bricks, mortar and coatings with the human chain system as described above. At Taanayel, an empty and useless barrel and an elongated wooden plank became the makeshift scaffolding. If the work pace needed to be increased the number of masons could be doubled and if several barrels were available, two to three different scaffoldings could be set up.

Fabrics in hemp, jute, sponge, *sfengeh*

Workers used pieces of fabric for many purposes. Things such as torn clothes, bands, or pieces of jute sacks, were used to; transport crops, wash the mold during brick manufacturing, help lay the plaster, wipe the tools, or to mop the workers foreheads or hands. Nowadays a sponge, *sfengeh*, is used instead.

Tools for the brick manufacturing step
Frames or mold

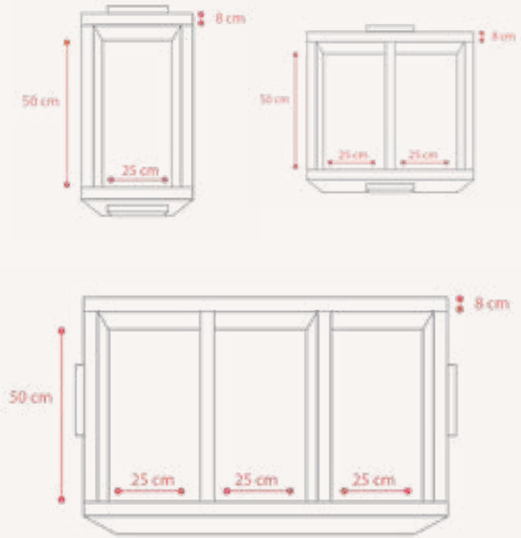
Qâleb or qâleb ṣabb, literally meaning mold and casting mold, or even *maqtaᶜ leben,* cutter of raw mud bricks, refers to the bottomless frame which is vital for making identically shaped mud bricks. It can be made of iron but constructors generally prefer the ones that are lighter, cheaper and easier to use. Because of the low cost and ease of manufacturing, they can easily be produced on the spot by the inhabitants.

The wooden frames are made with smooth sides to facilitate the extraction of the brick. The manufacturer places two wooden handles that help to extract the bricks after molding.

To work faster, the constructors can use various frames such as a double frame called *jawzeh,* which makes two mud bricks at once, or a triple frame, *moutallateh*, to make three mud bricks at once.

The terme *jawzeh* which means double, has become a generic term, so much so, that people often use the expression *jawzeh moufradeh,* which means "one" to designate the single-compartment mold and *jawzeh moutalateh, which means triple for the mold with three compartments. The double frame remains the most popular model, allowing the casting of two molds in a single gesture, requiring much less effort than the triple mold.*

The *qâleb* is the most specific tool on site because it is designed only for its main purpose. Whilst other tools may be repurposed, the mold is solely used for the manufacturing of bricks and, once this step is complete, it is put aside to await future use.



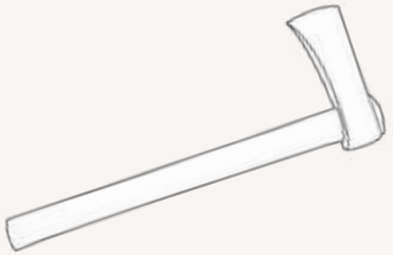
Tools for construction

The workers use a heavy hammer called *muhaddah*.to break the stones for the foundations. For the masonry, the tools of the master masons are simple, only the wire and plumb line, *belbol (later replaced by the zaïbaq*), spirit level), the flat hammer, *qaddûm,* and a trowel, *mastrîn* are needed.

The wire is used to take the measurements, and the plumb line, to ensure the verticality of the walls, during the construction. The master mason uses wooden planks to consolidate the angles.

The *qaddûm*

After the mold, the *qaddûmis* the second tool that is used during construction. It is mainly used to "cut" and resize the bricks. If the builder uses the bricks as they are, he sometimes has to work them, carving them gradually along the way in order to give them the necessary shape to fit precisely in their spot within the structure. For this, the mason must occasionally remove small excess parts, or break or shrink them as it is important to avoid leaving empty spaces between the bricks. During the construction of the dome, the builder sometimes needs to cut the bricks in half to fit them into limited spaces, or to gradually reduce the circumference of the cupola. When he needs to press the bricks into the structure to ensure the compression of the construction, he uses the handle of this instrument.



Qaddûm

Trowel

When they use cement in their foundations, masons make great use of the *mâlej,* a type of stainless-steel trowelused to smooth floors or the *mastrîn*, a trowel with rounded ends that has the shape of the palm of the hand. To apply the coating, they use the *mâlej* but especially the *meche*[c], an oval trowel with rounded edges and a handle in the middle. It is with the help of this *meche*[c] that the mason can add the mortar evenly over all the bricks, covering all sides and filling in any gaps between rows.

In the past, instead of using both tools (the *mastrîn* and the *qaddûm*), the builders used a single instrument called *mâlah* which has a base thickness of at least one centimeter and a solid thick iron handle. The *mâlah* mâlah serves as a trowel and, when turned over, its base can be used as a *qaddûm.*

Mâlej

Mastrîn

Meche[c]

Chapter 2

Brick making

The material

The clay bricks consist of a mixture of sifted soil, wheat straw, *tebn qamḥ* or *ḥenṭa,* and water.

Clay

In Syria the composition of the clay used in the construction of cupola houses is completely different from that used in Lebanon. Furthermore, within Syria, the clay quality varies greatly from one region to another. There is however frequent reference to a harder more resistant yellow clay. In the Taanayel site, we used the clay available in the Bekaa Valley, namely red clay, or *delghânî, which was used to build the clay brick homes in this region.*

Extraction site

In Syria, the clay used to build cupola houses was extracted from the soil surrounding where the builders lived, near the construction site, and often in the village itself. It was rarely transported from one place to another, to reduce material handling.

Local extraction of clay has become virtually impossible in Lebanon due to urbanization. Clay is now only provided by farmers rehabilitating their agricultural land, from builders digging foundations or during the process of creating drainage channels, or from specialized vendors. It is then transported directly to the building site.

Wheat straw, *tebn qameh* or *ḥenṭa*

The adobe brick is made using a vegetal degreaser and wheat straw fibers,*tebn qameḥ* or *ḥenṭa,* of two lengths (5 and 10 cm). Adding these fibers helps stabilize the clay and helps prevent cracking or splitting.

In Lebanon 5% to 15% of a stabilized material, such as lime, is added to the mixture to help harden the whole thing.

Quantity

The amount of clay and straw for a mixture to make 1000 bricks is:

- A truck of 18 m³ of clay
- A quintal, *qanṭâr,* of wheat straw
- Water to guarantee the plasticity of the clay

Preliminary step: assessing the number of bricks needed

Before starting with the clay bricks, it is imperative that the builders accurately estimate the amount of bricks needed for the entire construction so they do not risk having insufficient quantities during the building process. If this were to happen, it would be impossible to solve since hand-made bricks are unavailable to buy in the market; and if it is necessary to make additional quantities during construction, the process would require additional drying time. Once the initial evaluation has been completed, builders should, as a precautionary measure, add 5% more bricks to this assessment. Hopefully they will then be spared from any bad surprises later on, also since the cost of manufacturing is fairly low, it is better to plan for more than less.

Since it takes time to make and dry the bricks, it is best to start the job at the end of the rainy season, during the months of April, May, and June. It is possible to start the work later, but doing so carries the risk of not completing the project on time as it is not possible to work with earth materials in the winter. By choosing to start just at the end of the rainy season, workers will work in milder conditions that are less likely to dry out or crack the bricks, allowing them the time they need to properly plan the work.

In any case, it is imperative that the builders purchase plastic sheets in advance, to cover up their bricks in case of unexpected or unusual rain because of climate change. If it starts to rain without the sheets, it is too late to return to the site.

Construction time

Builders have April, May and June to produce the bricks and let them dry, and then a further three months for the construction stage. Evidently, this construction time depends on the financial means of the builder and the number of workers hired.

Manufacturing process and implementation of molded bricks

The manufacturing process of adobe bricks is very similar to that followed in several regions in the Near East.

The production area for mixing, pouring, and drying bricks

The area where the mixture is prepared must be as close as possible to where the bricks will be made in order to avoid unnecessary transportation and to minimize the risks associated with handling (for example, bricks breaking). If this is not possible, the bricks should only be transported once they have dried and lost their water content, thus making them lighter.

The production surface must be flat and clean to avoid the risk of picking up any pebbles, stones, impurities, or grass adhesion on the surface of humid bricks. To do this, workers should clean an area that can accommodate production, water its surface, pack it, and wait for it to dry before starting the manufacturing.

Mixing method

The soil intended for construction must be extracted from under the topsoil at a minimum depth of 30 centimeters. This is done to avoid the depredation of farmlands and to obtain soil with the least possible number of vegetal elements in.

To produce the mixture, workers proceed as follows:

• They take a pile of clay, add wheat straw (5 cm long) to the clay - *tebn qameḥ,* or *tebn ḥenṭa,* and dry the mix with a shovel and a pitchfork.

• They dig a pit at the center of the mixture, fill it full with water and then leave it overnight.

• The next morning, they break the mixture that should have hardened a little overnight, then knead it again with the shovel and the pitchfork.

• They then repeat the same steps again but this time they use their feet to stomp thoroughly on the mixture, whilst adding water little by little to rehydrate the clay, finally they add some more wheat straw but using 10 cm strips this time.

When preparing the mixture

Once ready, the mixture cannot be poured directly, it is vital for the bricks that the mixture rests first. This is why the mixing should always be done the night prior to the workday. Twelve to fifteen hours are needed to break up the clumps of soil, lumps of dirt and air bubbles which weaken the bricks and make them brittle. "When left to let rest, (the mixture) provides a supply of lactic acids, which are released by the straw after fermentation, and could be subsequently favorable to the hold »[7].

This process is meant to strengthen the material and make it more homogeneous. Additionally, enough water must be used to obtain a good mixture. If it is prepared the morning of its manufacture, the mixture would be too loose for it to act as a binding agent. It is therefore necessary to give the excess water, time to evaporate or to be absorbed by the soil to finally obtain a perfect plastic clay.

If the fifteen-hour timeframe is exceeded, the mixture may dry out, so the amount of time between the end of the working day (17:00) and the next morning (8:00), is ideal.

Once the mix is ready, the workers can start making the bricks[8].

7. O. AURENCHE, *La maison orientale*, 1981, Éditions Geuthner, p. 54.
8. Apart from this mix intended for pouring bricks, the workers will make the mixture daily, and sometimes several times a day in order to provide the mortar and binding agent necessary for construction.

Method of casting molded bricks

A worker fills a wheelbarrow with a shovel, *rafech*. Another transports the wheelbarrow to the work area and pours the mix in the double frames, *jawzeh*, or triple frames, which are placed on the ground and perforated to produce bricks of a regular size (see note on brick sizes). A squatting worker spreads the mixture evenly in the frames, making sure that the clay is well compacted, leaving no gaps, filling in the corners and any other nooks. It is essential to respect the thickness of the mold, which is why the worker must immediately withdraw any surplus and/or fill the gaps. He removes any excess clay with his hand keeping it nearby on the ground to reuse later when pouring the next bricks. He then smoothens the surface of the brick with his hand or with a trowel, *mastrîn*, then removes and raises the frame. He moves slightly and starts the operation again until he finishes his row of bricks. He then lets them dry on-site. The process must be done very quickly to eliminate any air bubbles, any additional waiting time increases the risk of the clay sticking to the walls of the molding frame, and therefore making the extraction of the brick much more tedious.

Some workers trace grooves and streaks into the surface of wet bricks, to help keep retention between surfaces, however, this is optional.

Bricks dimensions:
The shape and dimensions of the bricks vary by region. The bricks most commonly used in Lebanon and Syria are rectangular with dimensions: 40 cm long, 20 cm wide and 10 cm thick. For the construction of cupola houses, the master builder favored the use of bricks that are 50cm long, 25cm wide and 8cm thick.

Mold cleaning

The mold is regularly cleaned with a sponge soaked with water to eliminate adhesions on the frame walls and to facilitate the demolding process. The workers will judge the need for this step based on the thickness of the mixture. This step is usually repeated every two to three times per pouring process. If there are tenacious adhesions on the frame, the mold has to be soaked in water and washed very thoroughly. It is then left to dry so it is ready to use again the next day.

It is better to use two casting frames to get the job done quicker.

Drying

Drying at the place of production is an essential, crucial, and delicate step to avoid any deforming or cracking of the finished product. To do this, the builders must have planned for a significant work area from the start as the bricks have to dry flat which takes up a large area. The dimensions of this area depend on the size of the house being built, and therefore, the number of bricks needed for that specific project.

The process

To ensure homogeneous hardening the bricks must be rotated several times, so all the sides dry equally.

- The bricks are first left to dry flat
- They are flipped to the other side, still flat
- They are then placed lengthwise, sometimes two by two, one placed upon the other

The drying time varies according to the degree of heat and the current temperature, but in general, drying takes about ten days.

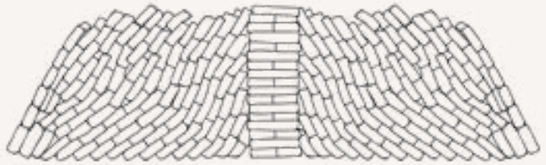
Under no circumstances should the bricks be spread over a plastic sheet, this would prevent them from drying by evaporation and absorption by the soil.

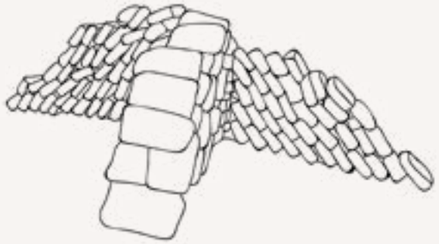
Stacking and storage:

Once the bricks have dried, they are grouped and stacked to clear the production area.

The workers start by putting up rows of 12 to 15 bricks laid flat to form a column. Two bricks are laid width ways then two in the opposite direction, or lengthwise to form a column. This column is used to support the rows of bricks which will then be stacked obliquely, or like stairs to the right and to the left and sometimes perpendicularly. If needed the workers will add one or two other columns to the same structure so as not to overload the first one. If there is not enough space, they will build a similar structure in parallel to the first but a few meters away.

The bricks are then left as they are until construction begins. The builder keeps the plastic sheeting he had set nearby to cover them as soon as possible, in case of unplanned and unexpected precipitation.





Chapter 3

The foundations

In Syria, the walls of the houses are sometimes built directly on the ground, without foundations. If the bedrock is exposed, it can be thickened by applying a soil coating to its base. In other cases, the walls are laid on an underground section - often superficial - made of rubble stone blocks.

In more recent times, if the master masons had access to cement, they often used this to lay the foundations.

The Taanayel cupola house is built on cyclopean cement foundations, consisting of a mixture of rubble and cement.

Implementation : the excavation

Once the land and wall's dimensions are defined with spray paint or white chalk, the workers excavate the soil using a mechanical digger and dig a trench with the dimensions 75-100 cm long and 50 cm deep, at the sites of the exterior walls and the interior partition wall.

The footing of cyclopean cement

Next, they work on the footing of the foundations, filling the trench with stones which they then cover with a layer of cement. While one of the workers takes charge of the concrete mixer hose, the others throw stones into the trench along the way. Once the concrete is completely cast, the workers use a shovel to smooth the whole surface.

Chapter 4

Wall construction: underbody and brick walls

Once the foundations are complete, the workers take new measurements of the ground and trace the boundaries of the house walls using lime, paint, or aerosol to cover the cement layer of the foundations.
The superstructure of the cupola houses consists of two superimposed parts, made of two different materials: the underbody, which is made of stone and the upper part, made of clay brick.

The underbody

Clay brick is a porous and hydrophilic material that breaks apart if it absorbs too much water. In order to isolate the clay brick portion of the wall from the moisture of the soil and prevent the risk of flooding, the master builder must first construct a base consisting of large rubble that he arranges and stacks vertically. In addition to providing insulation, this consolidates and stabilizes the base of the house.

Height

The base, built on top of the Cyclopean concrete foundation, consists of three vertical layers of stones. The height of each stone is between 27 cm and 28 cm and the overall base is around 80 cm.

Type of stones

Any kind of stone available in the area can be used. Limestone is most commonly used and often the stones are carved into to make them more suitable for construction.

Méthode de construction

At this stage of construction, the master builder is indispensable. He is the leader of the workers but most importantly; it is he who positions the stones. To do this, he uses a measuring tape, a plumb line, a bubble level and his *qaddûm*.

He begins with the angles, paying particular attention to the arrangement of the stones. He follows the line of the outer walls and the inner walls, and places the first stone on the first angle. Then, with his measuring tape, he measures the distance to the adjacent angle where he places a second stone and a string between the two angles. After consolidating the first angle, he moves on to the second. He then connects the two angles using a construction wire, *rabt*, and places the stones one after the other, disregarding the direction in which they are placed, as long as the outer side of the stone presents a smooth, flat, and uniform surface, giving a regular appearance to the construction. He chooses large stones and squares to obtain the necessary dimensions, so that they can be aligned next to each other to the nearest centimeter. He can raise or straighten them, using small flat stones that he can wedge in, if necessary, by pressing on them with his fist so as to obtain a straight horizontal line. He can also insert smaller stones, perpendicular to the larger stones. Once the first row of stones is placed all around the building, he begins the second row over it, in exactly the same way.

The base is sometimes partially or completely coated on the outside of the house, and always entirely coated on the inside. When the master builder decides to keep some of the stones visible; a decision he must make before initiating his work; he is even more meticulous in choosing and placing the stones.

When the work is done, the master builder obtains an underbody consisting of two non-paired walls. The gap between the two is filled

with any rubble of the stone shards, *kasr*, some of which come from the debris from the previous processes. The wall stuffing is called *hachweh in Arabic*.

Once this gap is filled, the workers use a shovel to pour in a binding agent, in this case concrete. In the old building tradition, before the emergence of cement, the binder was made of plaster, *jafsîn,* or clay mortar (mud and straw). As the work progresses, a worker adds small stones and smoothens the surface with a trowel.

He then proceeds in the same manner for the second and third rows. The tape measure, the plumb line and the bubble level do not leave his side during this entire process.

The process of laying the first clay bricks may then begin.
Once the construction of the house is completed and the plaster laid, builders proceed to a step called *takhîl* of the stone. This step consists of filling small gaps between the stones with cement, which has replaced clay mortar, used in the past.

Origin of the stones : Stonework

Before any construction begins, the site must be cleared of stones. The collected stones are then recycled and used in the construction. If the land does not contain enough stones, it is possible to buy them at low prices from farmers who clear their own land, or from specialized traders.

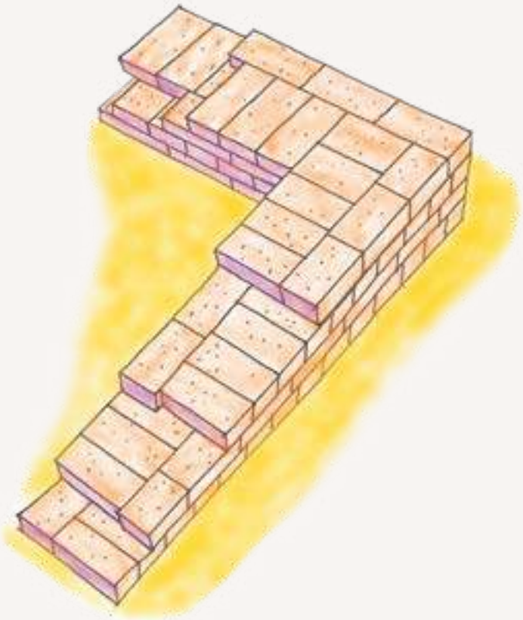
Clay brick walls

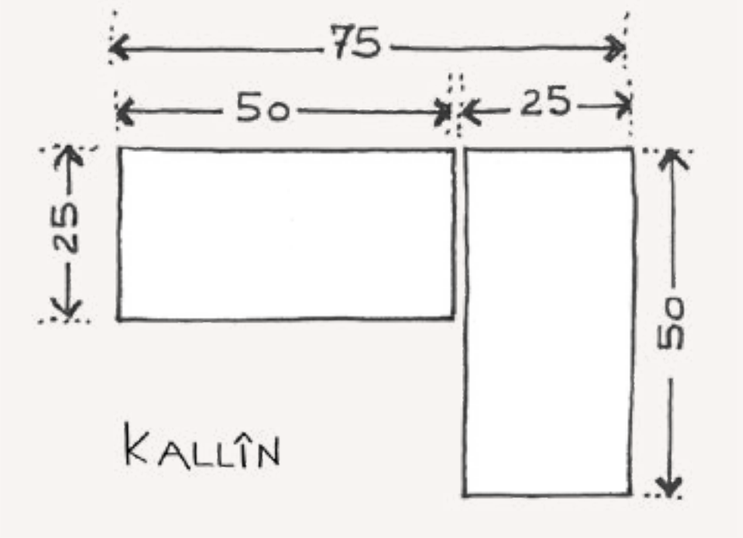
Once the stone foundation is complete, the master builder can begin building the brick walls. The height of the clay section of the walls of a cupola house ranges from 50 cm to 200 cm, according to the owner's preference.

Building method

The house does not have any columns, not even in the corners. The walls support the load of the roofing. The wall is built in successive layers of four rows *medmâk,* made of clay bricks, *lebneh*. As for the underbody, the master builder must start from the angles to build this wall. The workers place a long wooden board vertically on each corner of the underbody, to serve as a temporary guide. Then, the master builder sets the first bricks on two adjacent angles, one across the other, to form a chain of angles by laying the bricks in a stair shape, forming the beginning of the wall. He then connects these two angles by setting the bricks according to a pattern consisting of two header bond bricks on one side of the wall, and a running bond brick on the opposite side. The wall has a thickness called *kallîn,* a brick and a half), in this case 75cm, which provides good thermal insulation. The running bond bricks are offset by half a width compared to the two header bond bricks. For the next row, this setting is shifted by half a width, and inverted so that the running bond bricks rest on the header bond bricks and vice versa. Therefore, the bricks overlap, *tachrîk,* and are nested inside each other *mucharrakîn*.

When there are four rows of bricks finished, the master builder repeats the process by raising the angles. The guide board and its plummet line, *belbol,* allow him to ensure the verticality of the corner




75
50
25
25
50
KALLÎN


TACHRÎK

edge and the walls as he superimposes the layers.

The master builder builds the walls up to the height initially decided, after having determined the placement of the doors and windows.

The walls are then raised in several stages, 75 cm at the beginning, then 50 cm along the entire perimeter of the building.

Workers build 8 brick beds in one day. They must then wait for them to dry overnight, before they can continue to work on them the next day.

For the Taanayel double cupola house, the builder mounted 16 rows of bricks. Knowing that a brick measures 8 cm in height, and that it is necessary to add 1 cm of mortar per brick bed, they obtained a clay wall of 1.44 m in height. Including the underbody of 80 cm, the total height of the wall reaches 2.24 m.

Chapter 5

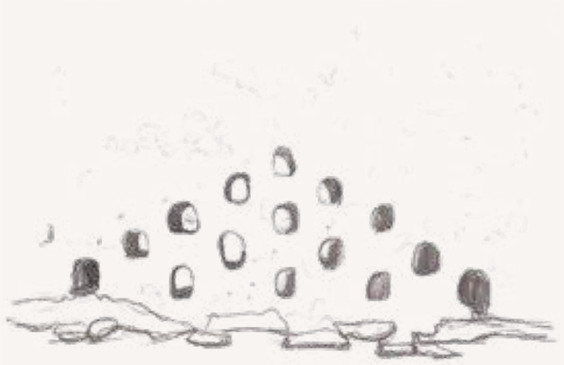
Openings, skylights, windows, and doors

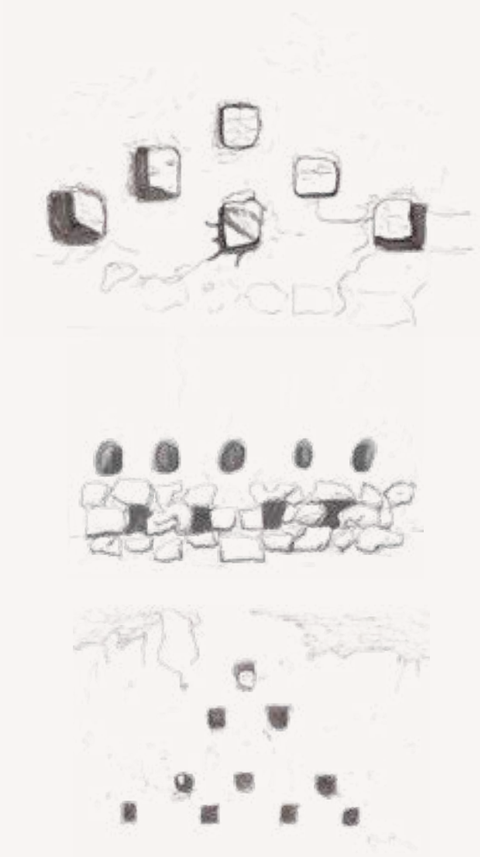
Two trapezoidal openings are also placed at the central height of one of the cupolas.

The mason (bricklayer) laid down two slanted mud bricks in order to create it and give it its shape.

To crown these openings, the mason lays down two slanted mud bricks leaning on one another to form a triangular shape, similar to a castle of cards, in order to distribute the load on both sides. It is at the time of applying the coating that the mason then gives these openings a rounded shape.

These shapes were familiar in Syrian constructions, and were used to fumigate smoke from the kitchen's cupolas for example, when baking bread.





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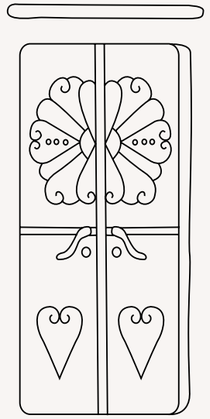
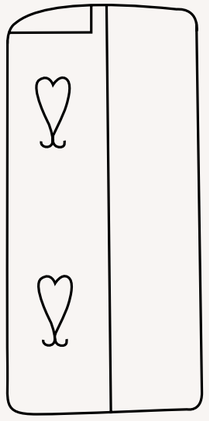
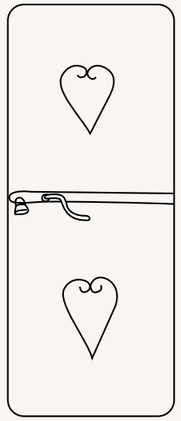
Doors

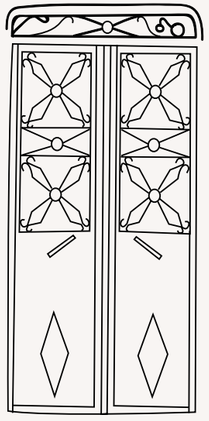
The doors of the cupola houses were usually shaped to allow the inhabitants sufficient space to live in. However, at the Taanayel site, the three doors (instead of the two in the usual construction) were placed at the center of the room to better meet the needs for which the construction was intended namely as a passageway and a shop (see description of the house).

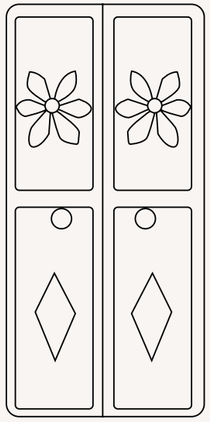
These doors and window panels combine an array of decorative elements inspired by those found in Syria.

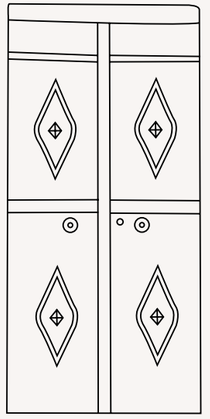


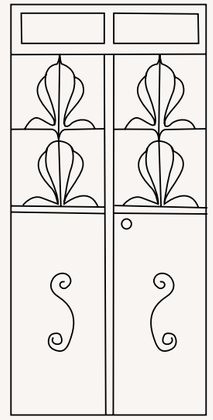


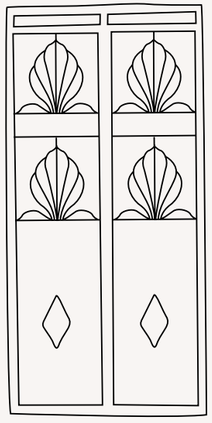


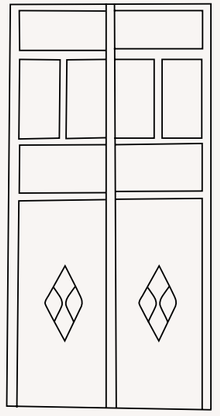


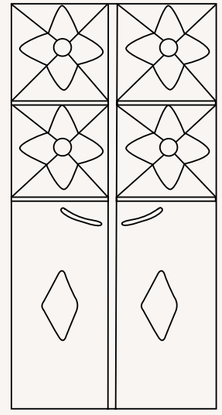












Execution : preliminary stage

The location and dimensions of the openings are planned before setting up the walls. The lintels, the timber frames, and the frames' anchors are prepared and stored on site in order to avoid wasting time during the construction process.

Lintels

Lintels are horizontal wooden transoms over an opening that carries the weight of the wall above them.

The choice of wood

The lintels are intended to support the weight of several layers of bricks and are preferably made of a solid wood such as *cedrus libanus*, *qetrânî*. In most cases, the bricklayer has to settle for a less noble or substandard type of timber which can be found in the surroundings of the construction site. As for the frames, bricklayers normally rely on chipboard.

Dimensions of the lintel

The wooden plank that serves as a lintel should be at least 20 cm wider than the opening in order for it to rest on the jambs on both sides of it. In the case of a 70 cm window for example, the lintel must be at least 90 cm long.

The width of the lintel is equal to the depth of the wall. However, the lintel may protrude from the wall or be recessed. From an aesthetic point of view, it is better if the lintel protrudes slightly from the outside. When a wooden plank does not have the required width needed for a lintel, the workers line several planks adjacently, side by side, without leaving any space; which is why the planks are squared on the side where they are joined. The bricks laid above must rest on 80% on the boards.

The thickness of the wooden lintel planks depends on the number of brick layers they are intended to support, and therefore, on the height of the wall above the window or door, as well as on the width of the opening. This thickness varies between 2.5 cm and 8 cm.

Preparing the planks

Before starting the process, the edges and the visible side of the planks are squared and passed under the jointer or the planer, *fârah*. The other surface, upon which mud and bricks will be eventually laid on, is left coarse. This roughness of the wood allows a better adhesion of the mud, which is advantageous since finding a suitable way to bind wood and mortar is a common and major problem for many earthen constructions.

Installing the doors

Doors are in general, 2 m high and 1.20 m wide. Setting up the frame must be done before casting the ground, which is then elevated 40 cm above the external ground level. The door starts at the bottom step, normally 20 cm above the external ground. The frames, well put up together by a carpenter, prevent air from infiltrating, thus rendering all pieces totally sealed and airtight.

It is impossible to attach these frames to the earthen walls with screws as this could cause the bricks to disintegrate. It is therefore essential to prepare wooden anchors for theses fixings instead. Anchoring must be done every 40 cm. A 2 m door would then require setting up five anchors and two or three per window. These are laid during the wall construction process, in order to avoid the need to bore holes into the wall and then have to fill them later with mortar.

The great malleability of the material should suggest that it is easy to seal the anchors after finishing the wall, but the work has a cleaner finish and is stronger when the anchors are planned and put in place beforehand.

Therefore, it is during the construction of the brick wall that the head carpenter should insert the trapezoidal piece of wood, wide side at the back and narrow side at the front. After having evaluated the thickness of the coating, he should put the wide part inside the wall whilst keeping the narrow part at the edge (at the emerged surface of the wall).

The bricklayers then screw the wooden frames to the anchors that were sealed in the wall during construction.

Tarring

In order to protect the window and door frames from insects and rotting, workers tar all parts of the wood that will not be visible, including the part of the door frame that goes into the ground as well as those that are hidden by the wall.

Chapter 6

Building arches for double-cupola or twin cupola houses

In order to make the best use of a larger space and to create two separate rooms, the mason (bricklayer) builds two joined cupolas. In the past, it was preferable to separate the two spaces in order to allow family members who wanted to sleep to isolate themselves, while others could still be awake in the adjacent room. A curtain or a simple piece of cloth was enough to conceal the space between the two.

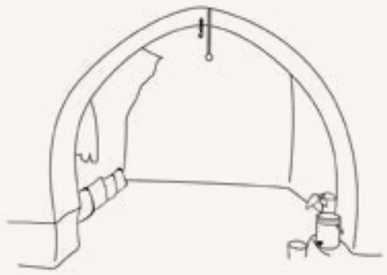
The opening in the common wall between both rooms is made in the shape of an arch, *qaws,* which the masons describe as difficult and complex to build and require much patience and courage.maçons comme un travail complexe et difficile, qui requiert patience et vaillance.

Typology of the arches used in building cupola houses

There are three types of arches: *qaws ardî, qaws muᶜallaq* AND *qaws hayzân.*

• The *qaws ardî, or ground arch*
This is the oldest known type. It is a parabolic arch that starts from the ground, *ard,* hence its name. The construction of this type of arch is the first to have been abandoned.

• The *qaws muᶜallaq, or beam arch*
This is the intermediate model composed of an arch that does not rest on a pier, but rests directly on the wall and is generally about one meter high. In a house with a suspended arch, the wall, up to the height of the bottom of the arch, goes from one room to the other. The house therefore looks much like a rectangular house with a flat roof, *dar*, , rather than a cupola house and looks larger on the inside.

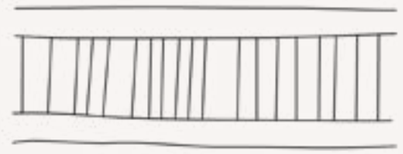


Qaws ardi

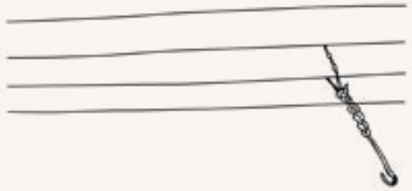
Qaws muᶜallaq

• The *qaws hayzân,* lor beam arch
Literally called the beam arch, although it does not have the shape of an arch but is rather an opening made of wooden lintel. The *qaws hayzân* represents the most recent method of construction; the word *hayzân* refers to any transverse beam. Initially, in the countryside where cupola houses were built, the masons (bricklayers) did not have the necessary wood at their disposal to make beams. They were sometimes able to procure it from the cities; however, transportation costs were very high. The advent of modern means of transportation thirty to forty years ago, made the use of wooden beams much more common and allowed numerous inhabitants to incorporate them in their constructions. Setting them up required less effort and work. It was easier and less time consuming to allow the elimination of the delicate concordance phase, *dawzanah*, between the two parts of the arch. Two to four beams – depending on the depth of the chosen opening – are transversally placed between both rooms of the house. The mason lays bricks on the top and uses wooden planks, *daff,* as camouflage.

On the construction site of our cupola house, we opted for the first type of arch, the *qaws ardî.*



Qaws hayzân



Qaws hayzân

The foundation of the arch

Whilst plotting the foundations of the house with chalk on the ground, we planned the placement of the future arches.

The master mason starts by placing his first row of bricks over the bedrock of the arch, *rejel,* a pier made of three foundations of stones about 80 cm high.

Afterwards, he positions two bricks horizontally over the wall which is around one meter thick. Then in order to ensure the overlapping *tachrîk,* he places the rest of the bricks in opposite ways to bind them together, *rabt*. The rows of bricks are therefore alternatively arranged: two horizontal bricks followed by two vertical ones.

After that, he builds three rows and proceeds with the leaning curve of his arch. To achieve this, he must move each new row forward by two to three centimeters until he reaches the arch's closure. As soon as he begins to shape his curve, he installs a centering to consolidate his work and to avoid any danger of collapse during the construction process.

The centering

L'The arch that is now beginning to take shape requires a curved scaffold for support referred to as the centering, *qâleb,* or *sandeh.*

The master mason, supported by the other workers, installs the brick mud centering that will prevent the arch from collapsing in the future. Due to the absence of wood in the construction areas of the cupola houses in Syria, the centering is normally composed of a mass of mud bricks or jute sacks filled with grain.

In our case, the mason arranged a scaffold from 2 barrels over which he placed a wooden plank. On this plank, he laid various rows of bricks arranged lengthwise.

Obviously, this method is only one example and the details of placing the centering depend on the dimensions of the arch. The important thing is that the builder creates a temporary structure that is as solid and as firm as possible, so that the arch can rest on a base that supports it whilst it is still damp.

The bricks that are used to manufacture the centering are of course laid without mortar as it is a temporary provision that must be easy to dismantle at the end of construction.

The building method

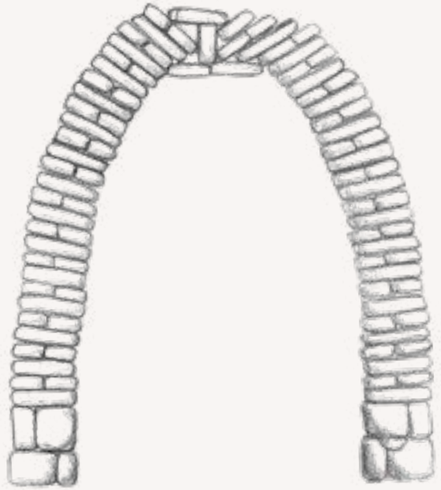
Aiming to build an arch of more than two meters, the master mason mounts 28 rows of bricks. He works alternately between sides, on one side then on the other. He raises the first side then leaves it to dry for a few hours while he works on the second. The drying time primarily allows the consolidation of the basis and the progressive shaping of the arch. The master mason stands on the wall behind the arch and, alongside the work in progress, forms the top of the centering. Upon sealing his arch, he has no other choice but to stand in the center, on the centering, which must be solid enough to support his weight.

During the drying time, the mason does not rest, he moves to the other side, mounting the same number of rows of bricks, which he also leaves to dry afterwards. The alternating work is also essential on both sides of the arch, *dawzana*, so that the symmetry of the whole construction is respected. The rows of bricks that face each other *muqâbel,* must be built exactly at the same level, *sâwiyah*. so, upon the arch closure the last bricks naturally interlock with each other.

The arch closure

Once the bricks of the arch are positioned in a corbelled manner, resulting in a final V-shape, the master mason must close the arch.

In the center of the still open space, he places a vertical brick, used as a keystone, flat on the edge of his centering, caught in the tension between the two sides of the arch. He then fills all the voids and gaps on either side with half bricks, bricks debris and mortar until the arch is completely closed.



Working time

Building an arch requires two working days.

Drying time

It is also important to respect the drying time which can last up from one week to ten days before dismantling, *fakk*, the centering. Mud bricks which form the temporary centering are removed, one after the other, and so is the rest of the scaffold. The arch, now dry, is hence consolidated. The final height of the Taanayel cupola house

Protective coating, correction coating

When the arch is complete, and before the builder does his finishing touches, he spends time reforming and refining his work.

The earthen architecture is handmade. Therefore, the curve of the arch will never be perfect despite the efforts made to ensure its symmetry. For this reason, the master mason tries to blur the imperfections in two stages. He begins by removing any protrusions with his qaddûm, before the leveling (smoothening) operation. Then when it is time for the levelling, he coats the arch in order to remove and erase as much imperfection and unevenness as possible. Finally, in order to obtain a homogenous curvature, he adds an extra coating to the hollows to even out the overall line of the structure. Clearly, the imperfections are still apparent, but they add charm to these houses smoothed by the hands of Man.

Number of bricks needed to make the arch: approximately 225 (4 per row, times 28 rows from each side, equals 224 bricks to which are added about 25 replacement bricks in case of a breakage or any other contingency).

Chapter 7

The construction method of a double-cupola or twin cupola houses

Types and number of cupolas

In the regions where wood was scarce, the cupola was developed for the roofing of houses, instead of using wooden pillars and beams to allowed the builders to take advantage of the cupola's conical shape, whilst also protecting the roof from the strong sun.
Cupola houses are extremely diverse. Some are built as circular plane, others are mounted on a cubic base, and they come in different heights[9] and material[10] . Some houses have one or two cupolas and others have even more. The largest houses we've seen had sixteen cupolas! These models depend on many factors and parameters: topography of the site and the available amount of land, abilities, needs, requirements, and willingness of the future owner. It is he who chooses the dimensions, and the model depends on his preference as well. Thus, as summarized by one of our interlocutors, "some wish to build a palace, others a big house, whereas the modest means of some only allow them to afford a simple and modest house". The master builder will work according to all to these demands.
There are no fixed rules for determining the starting height of the cupolas, and the options are numerous. Some start from the ground, others start at sixty centimeters, one meter twenty, or two meters. This choice will determine the height of the cupola itself, which when finished, could reach up to three, four, or even five meters.
In other cases, these cupolas are reduced, and some houses are surmounted by a half-cupola or a flat cupola. The builder, makes an opening in the ceiling with a circumference of two meters or a meter and a half, and covered with plant fiber mats, reeds, qasab, or small beams on which he puts straw and clay. Thus, the cupola is truncated from its upper part and replaced by a wooden structure that supports a flat cover[11].
Despite these variations, the builders agree on certain shapes to strengthen the building, such as a square plane of 4 meters per side which ensures good foundations or starting the pillars at two meters high. Apart from the technical advantages that this presents, this choice is wise and practical as it creates a larger volume of space on the ground, useful for accommodating large rural families, and vertical walls are always easier and simpler to use than sloping walls.

9. The height may vary between 0.3 m to over 2 m
10. The cubic base may be homogeneous or heterogeneous. It can either exclusively consist of clay bricks or of mixed stone for the foundations laid by clay brick walls, or entirely consist of clay-covered stone.
11. It seems that the adoption of these truncated cupolas is due to practical concerns. The cupola is fragile and may collapse due to harsh weather. By eliminating it, the builders opt for a half-way solution: they stay away from danger and, at the same time, spare themselves the worry of repairing the higher parts, which are the most difficult to coat.

El thyâkh or el *Jbaᶜ*

The cubic base of the house is usually wider than the cupola itself. This part, which forms a sort of platform which cover the walls of the dwelling, is called *thyâkh* or el *Jbaᶜ* sby the builders, depending on whether they are nomads, *bedû*, or sedentary, *ḥadar*.

The dimensions of the *thyâkh* vary depending on the dimensions of the bricks being used. It should have the same dimensions as a brick laid widthways measuring around 20 or 25 cm.

It is on this *thyâkh* that the masons stand when building the cupola. It also allows them to move around during the regular maintenance of the house whilst coating repairs and to evacuate the water and protect the walls of the house: a piece of plastic, unused tinplate containers, or sheet metal can be used to direct water away from the walls,

In the case of our cupola and to ensure the house was fully waterproof, the builders covered it with sheet metal plates and built a humpback that they call a camel-back, *ḍahr el jamal*, to facilitate the evacuation of the water.

The construction of the cupola

The square space of the interior of a single cupola should ideally be 4 meters per side. In the case where the builder seeks the construction of two attached cupolas, *qubab muᶜalaqa,* or pair of cupolas, *jawz qubab*, the square will become a rectangle, with the length being double to the initial side.

Elevation method of the corbelled cupola

The construction of the cupola is naturally the most difficult stage. It requires concentration, consideration and precision. It also requires the team to be patient, because a cupola cannot be built in one step, and it is imperative that no steps are skipped in order to achieve a solid construction.

The laying of the first brick foundation, *medmâk,* is crucial. It dictates the future success of the construction, if all the calculations are correct, the cupola will turn and roll, *tleff,* and it will automatically start to take its oval shape.

Construction of the cupola without a centring

Unlike arches whose construction require the installation of a centring made of jute sacks or more often clay bricks, the corbelled cupola built with bricks horizontally placed one on top of the other, does not require a vault hanger or scaffolding.

The base: *tha^{c}lab,* foxes

The cupola is built on the walls of a cubic base. To move from the square to the circle, the master builder begins to raise it from the corners, so that he can wrap it, *laff,* and rotate it, which he does by moving its rows of bricks gradually to the inner side. He narrows and collects, *lamm,* his work in the shape of a spiral until the cupola is formed. And to facilitate the rotation process, the master builder places stones or small flat beams, named *th^{c}alab,* lor fox, on the four corners of the cubic base. The *tha^{c}lab* can be made of stone or hardwood. If wood, it is usually *qetrânî or* Cedrus Libanus. On the Taanayel site, they are made of wooden boards measuring 80 cm long, 20 cm wide, and 8 cm thick. Sometimes if there is a surplus of wood, the builders place an extra small piece, at the back of the first *th^{c}alab* to cover the open space that remains.

Laying the *tha^{c}lab*

The height at which the *tha^{c}lab* lab is placed depends on the height of the cupola. In our construction, they were placed 170 cm above the ground and 25 cm lower than the door lintel which measures 1 m 95.

Before laying the *tha^{c}lab,* the master builder takes his measurements from one angle to another to make sure that the diagonal is exactly five meters, and equalized with the spirit level. In order to initiate his curve, he places his *tha^{c}lab* over the angle, projecting 20 or 30 cm out from the wall[12]. Once the first corner is postioned, he moves on to the other 3 and repeats the steps. At this point, he can proceed quickly because the other masons have already prepared and tarred the *tha^{c}lab* (see notes).

12. D'autres comptent 30 cm.

Treatment of the *tha^{c}lab*

Before they are put in place, the *tha^{c}lab* needs two specific treatments. Firstly, they undergo an oil treatment two days before they are set, to make them waterproof. Then, they undergo a partial tar brushing to protect them from insects and rotting. The parts that are not intended to be seen are painted after having been placed exactly where they will be fixed, as was done with the frames, doors and window frames. The parts which will remain visible from inside the house will be left in their current state.

Layout of bricks

Whenever one of the four *thaᶜlab* is in place, all the necessary measures have been taken, and it is fixed in its exact place, the master builder places 3 bricks all around it and smears it with mortar to consolidate the small board and to refrain it from moving. In case any small empty spaces remain, the master builder can reduce a brick with his *qaddûm* dto make the perfect shape for the space that needs to be filled, he inserts it and then covers it in mortar. Whilst the master works on the walls, a worker on the ground plugs the small gaps that remain around the *thaᶜlab* but this time from the inside. The master builder repeats the operation for each one of them. Once the work is done, he connects them with a row of simple bricks, laid flat and lengthwise.

Development

Once the first row of bricks at the *thaᶜlab* is mounted, he begins to set up the next row lengthways. The bricks are placed side by side and connected by a thin layer of plaster everywhere except above the *thaᶜlab,* where they are placed in a fan-like pattern.

It is at this point that he begins to reduce his perimeter and to make turns to shape the circle of the cupola. To do this, he moves in a circular direction, letting part of the brick overhang. To be more specific, he gradually moves each row of clay bricks, *dawr,* proceeding as follows: he uses his four fingers to measure the reduction, usually about 5 cm. By reducing the perimeter each time by 5 cm on a 50 cm brick, he keeps 45 cm at the back of the structure, which consolidates the building. It must not exceed 5 cm, otherwise the rest of the brick will be top-heavy and the front part will not support the weight and will consequently break the brick. Thus, the first *medmâk* will extend about 5 cm, and the same goes for the next row, and so on and so forth until we reach the top cupola and its closure. To take his measurements, the master builder can use a meter, but usually he assesses the distance using his hand. Everytime he wants to start a new row of bricks; he refers to a vertical spindle at the center of the cell.

From one meter upwards the construction of the cupola becomes more difficult, and the labour more strenuous.

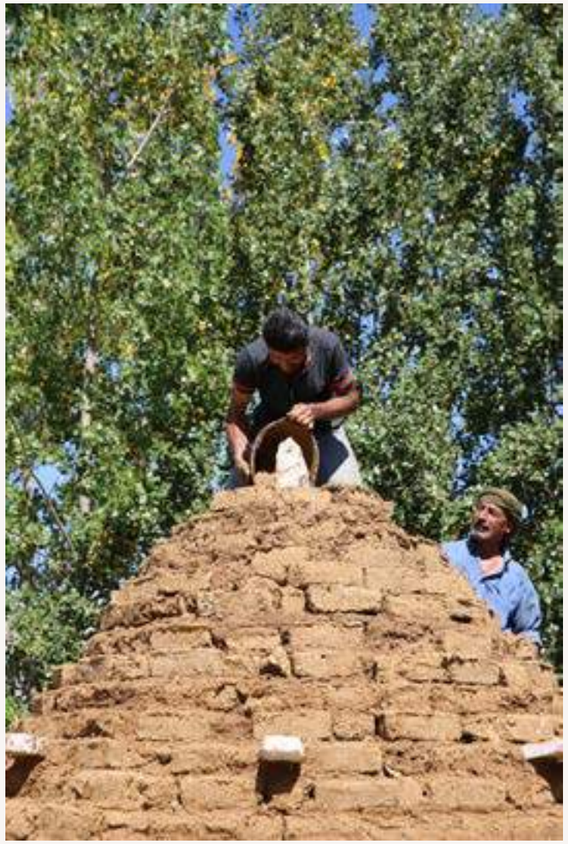
Respecting drying time and number of rows per day

One of the basic rules of building a cupola house is not to rush and to work gradually to ensure full strength of the building. Building the base, the walls, and especially the cupola, must be done gradually, taking into account any limitations, namely by respecting the amount of time needed for drying. When the work is done in the middle of summer, the high temperatures make drying faster however not enough to avoid waiting times fully. This is why building the cupola takes time.

Builders, as construction progresses, must wait until the bricks they have put in place are completely dry and have fully adhered together before resuming. The latter, depending on the weather, need a day or two to dry thoroughly. In cases where temperatures are moderately high, bricklayers erect four to five rows of bricks a day. However, since they usually work in the middle of the summer, they may reach up to 6 to 7 rows daily. If it takes 1 cm of mortar per brick and each brick is 8 cm thick, then each intervention will be 54 or 63 cm in height.

Bricks must be completely dry to withstand the new rows but also to support the weight of the master builder who has no choice but to move forward with the construction by sitting a stride the cupola, his feet hanging down on either side.

When building a double-cupola house, the master builder has a simple solution that allows him to not delay the work and to respect the drying time simultaneously. He goes alternately from one cupola to another. He begins by building the row of bricks for the first cupola, and while they are drying and resting, he moves on to the second and repeats the step. The next day, all he has to do is resume work on the first cupola, and so on.



Sealing and closing the cupola: *khatm el Qubbah*

The master builder finishes the last rows and prepares to seal the cupola. To do this, he places four bricks in the shape of a cross and inserts vertically, in the center of this cross, a stone 35 cm long, 10 cm wide, and 10 cm thick, called *ṭanṭûrah*[13]. He consolidates it by surrounding it with half-bricks and earthy mortar. Some builders skip laying the stone whilst sealing the cupola, and instead seal it using only clay bricks.

13. The *ṭanṭûrah* is also called *qamouᶜ*.

Preferably, only one master builder will work on a cupola. However sometimes, to save time, we employ two builders for this task. There would then be a big chance that, in order to go faster, the latter would use their fingers rather than the meter to measure the progression of bricks, and since the sizes of their hands will be not identical, the cupola may be somewhat distorted.








The camel back, *ḏahr el jamal*

The donkey humps or backs, referred to as camel backs in the local dialect, are placed above the house walls primarily for aesthetic purposes, however it can also be used to ensure the evacuation of rainwater. They embellish the Syrian houses through their shape and curviness. In the cupola house of Taanayel, these donkey backs were placed on all sides of the construction, except for the side with the outer gallery.

Above the *tyâkh* the masons place a first bed, *medmâk,* of seven bricks centered and aligned with the wall, to arrange the camel backs. They install 5 rows from which they subtract a brick or two each time, until placing a final one in the last row. They arrange them to ensure their imbrication, *tachrîk,* similar to the construction of the walls. To consolidate the structure, they fill the void between this new element and the bottom of the cupola, with bricks or pieces of bricks and earth mortar. In the final stage of the edification of the camel backs, they reduce the staircase effect by adding residues of bricks or earth mortar to the extremities of each level. They then smoothen the whole surface with a coating to give it its final rounded shape. Some masons prefer to place a bed of bricks on the camel back that they constructed themselves.

It must be noted that the back of the arch, *ḏahr el qaws,* is naturally formed by the curve of the internal arch placed between the two cupolas. This arch facilitates access to the first *duwwâsât* during the various coating stages that take place.

The *duwwâsât*

Each region of Syria has its own way of accessing the higher parts of the cupolas. Where they have wood, the inhabitants use ladders, but this solution is not practical because the builder is forced to constantly move them. In some villages, they use ropes or apply a method of digging holes, as construction progresses, in which they put their feet, and fill and close once the work completed. However most commonly, they add projecting stones called *duwwâsât,* during construction, which are inserted on the outer side of cupolas, at their circumference. The *duwwâsât* (from the verb dasa, to set foot) thus allows those who will lay the coatings or undertake regular repairs, to move around the cupolas more freely and to reach the top.

Types of stones and dimensions

For the *duwwâsât*, different types of stones are available to use depending on the surrounding environment or near mountainous areas. Some builders use smaller stones that result from the earlier work on the foundations.

To avoid additional work, they try to choose stones that naturally present the prerequisites: rectangular in shape and accurate in size. When this is possible, they use the stones as they are, otherwise, they are forced to carve them to fit their needs.

Part of the stone therefore remains on the outer part, since the builder must be able to put his foot down on the stone whilst he fits the other part between the bricks, in the same structure. For this purpose, the length of each stone must be at least two spans, *chebr,* namely about 40 or 45 cm (depending on whether the builders measure the size with their hands and calculate in spans or do their calculations in centimeters). One span will be inserted whilst the other remains protruding. The width of the stones can range from 20 to 25 cm.

As for the thickness of a *duwwâsât*, it should preferably be 8 cm so that it can be aligned with the thickness of the clay brick, and so the row of bricks remains straight after insertion.

Number of stones and rows

The number of stones required depends on the size of the cupola. The more stones in a row, the easier the subsequent maintenance work. However, there are standards for calculating the quantity of stone required, and this number is determined by the height of the cupola. Thus, for a height of three meters, a cupola requires about 30 *duwwâsât* which lie in rows one above the other.

The number of rows also depends on the height of the cupola. Generally, a cupola has two rows of *duwwâsât*, separated by a distance of about 1 m 50, to allow the person who is laying the plaster in the center of the cupola, to stand on the lower row and cling onto the stones in the rows above. To coat the highest part, they stand on the second and last row of stones and hold onto the *ṭanṭûrah*, the vertically inserted stone that seals the cupola.

Spacing between *duwwâsât*

The *duwwâsât* are interspersed at regular intervals between the different rows of bricks. Some builders choose to insert them half a meter or a meter away from one another, but in general the difference between one *duwwâsah* eand the other is calculated according to the steps, *fachkhah* or *khachfah* (according to Syrian pronunciation), of an adult man, averaging around 80 cm.

When a worker climbs up onto the *tyâkh,* he starts by climbing onto the hump of the arch at the intersection of the two cupolas, which allows him to hoist himself up to the first rank of *duwwâsât* more easily. From then on, it will be easier for him to move from one stone to another by clinging onto the stones in the second row.

Insertion method

The *duwwâsât* are usually inserted during construction. The bricklayer leaves a space for this purpose when aligning the rows of bricks. He spreads his mortar on all the sides of this empty space, sets the stones, adds mortar over them and continues onto the next row. So that the stone is most securely fixed, *mouthabbata,* in the structure, the builder must make sure he fills any spaces or gaps with mortar. Other builders opt to insert the stones after the completion of the construction and leave a hollow space in the bricks when coating and plastering. However, this method is less advisable, as inserting the stones during construction makes it stronger.

How to use the *duwwâsât*

When laying the plaster, the builder in charge works from top to bottom, and stands on the highest part of the hump separating the two cupolas, namely at a height of 1 m 10, which allows him to reach the nearest and most accessible *duwwâsâh*. He then passes from one *duwwâsâh to another until he reaches the top row where he stands with one hand gripping the ṯanṭûrah* and the other coats the highest part of the cupola. Once the work is done, he goes down one row to coat the middle part, and then goes on the *tyâkh* where he stands to coat the rest of the walls at his height.

Time of construction of the cupola

This time frame relies on several factors, and could span from a week to ten days, or more.

Chapter 8

Coating

« Which traveller has not felt the same impression, before these landscapes, that builders do not violate, as their volumes, softened by the coating they are wrapped in, blend into the same world they were extracted from? »[14]

Olivier Aurenche

While some types and buildings of solid constructions can survive without a coating, it is an essential element for clay constructions, since clay is a fragile material that is particularly vulnerable to water. Despite the progressions (more or less wide) of the roof, intended to protect the vertical walls from the rain, which are featured in some houses, and though they can be located in areas with low rainfall, precipitation remains a major risk. Coating is therefore done to ensure the longevity of homes by protecting them from the infiltration of rain water and erosion. Therefore, most builders insist on coating their houses both on the inside and out, with one or even several plaster layers, as well as a finishing plaster.

Not only does coating extend the life of the house, it also guarantees thermal comfort in the clay constructions. It also reinforces the walls and give them their inertia. Coating insulates the interiors of houses and regulates the rooms' humidity.

Coating serves another important purpose which is, although less pronounced, to improve the appearance of the house. If houses were kept in their original state, they would lack some finesse. "In general, the first coating is thick, consisting of a rather coarse plaster that serves as support for a finer whitewash that gives the wall its final appearance."[15] This coating can be used to hide and conceal imperfections in the house.

As for the interiors, it was through this coating that women tried to perfect and decorate their homes, the only available ornaments and embellishments were clay moldings that often adorned extremely bare interiors.

In the local building traditions of Northern Syria, and in the areas in where cupola architecture is present, builders apply a single plaster layer, which is more resistant due to the specificities of the clay used. They then cover it with a finishing coat consisting of liquefied white clay.

On the other hand, in the local building traditions of Lebanon, and with the clay being less resistant, builders apply two layers of coating: a red coating and a white one, followed by a finishing plaster. (Annexe 3)

The number of coatings as well as the number of layers applied therefore depends on building traditions and the nature of the base support.

For the Taanayel cupola house, we chose to apply three coatings of two different clays, and several layers were applied to the interior as well. All the plaster layers consist of a mixture of clay and straw apart from the finishing plaster which is only clay.

14. O. AURENCHE, *op. cit*, p. 138.
15. O. AURENCHE, *op. cit*, , p. 136.

Red coating layer : Type of clay and preparation

The clay used to make the plaster is the same red clay, *delghânî*, which was used to make the bricks but which, at this stage, was made more malleable.

Preparation of the mixture, *jableh*

Depending on the region, either men or women, or both, worked together to apply the coating. However, in some areas where only men were in charge of this task, with many absent due to economic reasons, the roles were reversed and the line between the gender roles became blurred.

The mixture is always made as close to the construction site as possible, to facilitate the transportation of materials.

As is the case when making the bricks, the mixture for the coating must be prepared a day earlier than its scheduled application. The quantity depends on the number of workers, too many of them as well as too little, is to be avoided. And even though this mixture has a life of two to three days, it is better to prepare it according to the work's progress. That is why workers prepare it daily, at the end of their workday.

This method is similar to that used for making bricks, however now a sieving step is added. The workers must sift the soil to make it very fine and free of pebbles, plant debris, and other impurities. For this purpose, they use a sieve with holes 4 millimeters wide. Then they set it in piles, and dig a pit to pour water and a vegetal degreaser in, which help binds the mixture together. However, opposite to the brick-making process, the builders use barley straw, *tebn ch*ᶜ*îr*, instead of wheat straw, because it is much thinner which, therefore, facilitates smoothing and prevents cracks from forming. Workers then let the mixture rest until the next day so that it ferments, *yakhtamer,* and becomes "ripe" and ready to use, *yastawî.* This fermentation mainly allows straw celluloses to release "glues that give the coating a water-tight mix»[16].

The next day, before starting work, workers knead the mix with the shovels, and add water if necessary, to make it easier to work with. The proportions (100 kg of soil to 10 kg of barley straw) are the same as those used for the brick mixture, plus an addition of 15% of fine lime, *kels,* which reinforces the coating. In Syria, in areas where clay cupola houses are built, adding lime is not as common, as the soil used in such areas is more resistant.

Applying the red coating

Preliminary step: checking and preparing the base

Before applying the coating and so not to intervene after the construction is complete, the workers must ensure that the different frames of the doors and windows have been installed correctly. Also, the wooden frames which will house the electric plugs and outlets have to be well embedded into the wall before they can be coated.
Similarly, they must prepare the supports and gripping surfaces and make sure that they are uniform and clean. Using a long ruler or a wooden stick, workers identify any defects in the walls to coat. In order to achieve an even surface, they break any protrusions with the *qaddûm,* removing anything that emerges, and trying to smooth the surface as much as possible. They must not lead any voids, or crakes or holes as this could lead to water leakes inside the building. If there are some samll holes and crakes, thy can stuff them with plaster. However, if they are bigger, workers add small stones. Once the protrusions are removed, the holes and cracks are filled, the reworking and filling layers have dried and the surface has been smoothed, workers can start applying the first layer of plaster. It must not be too thick at this stage as this would quickly cause cracks in the walls. Generally, the thickness of this coating should be 2 to 3 cm.

To guarantee better adhesion, they spray the bricks and moisten them with a big brush, a bowl, *kayleh,* or even a garden hose *nabrîch,* because if they are too dry, they may absorb all the water of the plaster, thus resulting in numerous cracks. If the walls have been recently built and are still wet, this additional humidification is unnecessary.

16. V. LEROY, P. BERTONE, S. WHEELER, *Les enduits de façade. Chaux, plâtre, terre, 2011, Paris, Editions Eyrolles,* p.90.

Transport

A worker transports the mixture in a wheelbarrow to the site. Another fills the baskets, *zanbîl* or *quffat,* with the mixture to provide the builders with plaster. For the higher parts, the workers form a human chain - as they do for the bricks - to make transporting the baskets easier. A rope is sometimes used to hoist them up to the people in charge of this task.

In order to allow the builders to concentrate exclusively on their task and to avoid interrupting their work, thus delaying it, the helpers immediately refill the mixture as soon as it runs out. In order to avoid any wasted time; builders and workers, must work in complete synchronization.

Applying the coating

The best method to apply the coating, callede *ṯalṯîch,* is to throw small balls of mortar up and down small sections of the wall, after moistening the treated surface, and then smoothing it. Many people favour the use of bare hands for smoothing. Some, however, prefer wearing gloves to protect their skin. Gloves can make the process easier, as gloved hands slide more easily. Workers then smooth the surface with a large trowel named *meche*ᶜ. For better adhesion, they cover the seals between the different textured materialswith their fingers.
The workers work from top to bottom to apply the coating.

Drying time

Once the application is complete, the workers wait three to four days for the walls to dry. It will inevitably develop cracks however if the crevices and cracks that appear are too numerous, they will be filled with clay mortar, and if need be, a second layer of plaster, finer this time, about a centimeter or so thick can be applied. The micro cracks that eventually appear after this operation will be later filled with white coating.

Coating arches and cupolas

The coating of the inner and outer arches is done in two stages. During the first stage, builders fill the steps of the arches, *ṯadaroujât,* with clay and then smooth them down to give them their final shape.

The same method is applied on the exterior of the cupolas. Not only does coating protect them from water infiltration, it also aims to give them their final oval shape by blurring the steps. That is why they are referred to as eggs.

When applying the plaster on the cupola, the person in charge must work alone because of the limited space available. Therefore, to plaster the higher parts of the cupola, the worker advances on the upper row of *duwwâsât* dby gripping the *ṯanṯûrah.* Then he goes down by row whilst continuing to work with one hand and clinging to the upper *duwwâsât* with the other, he moves in a circle, this time on the lower *duwwâsât* followed by a chain of workers who stand at different levels and move with him providing the materials.

The inner part of the cupola is usually left as is. The reasons can be mundane; in fact, its height makes it inaccessible and impossible to reach by the inhabitants who, in the best of cases, only have a three-meter-long ladder, thus not high enough. Builders often settle for spraying it with finishing plaster, reaching only as far as they can throw it.

Residues from the plaster that fall on a clean floor during work can be re-kneaded and reused for other steps. But if they have been soiled by the impurities of an unclean soil, they will no longer be of use.

Once the red plaster coat has thoroughly dried, workers move on to apply the second coat, but only after having respected the required drying time between each layer of plaster.

White plaster coat *ḥuwwâra*[17]
Extraction site in Lebanon and Syria

In Lebanon, this limestone *ḥuwwâra* is found on the flanks of Mount Lebanon, in Anti-Lebanon, and in several regions of the Bekaa. There are a large number of these stone quarries in the Northeastern Bekaa (Chemestar, Beit Mcheikh and Beit Sleibeh), Central Bekaa (Zahle, KfarZabad, Ain kfarZabad) and West Bekaa, on the Rachaya side. Often, the municipalities in these regions carry out works (roads, roadways, etc.) that require the extraction of this soil. One can arrange to buy it at a price roughly equivalent to that of the red earth.

In Syria, there are extraction quarries maqlaᶜ· where one finds this white soil. Sometimes, when the villagers dig a well, they find it deep down in the soil and store it in bags to use in due time.

Composition

• Water
• White earth, *ḥuwwâra*
• Barley straw. If red coating consists of wheat straw, white coating, however, requires barley straw, *tebn chᶜîr*, which is much thinner and can be well sanded afterwards
• We can add 15% of lime, in which we put a little salt. Lime strengthens the coating. In Syria, as is the case for the red coating, white soil is used without lime.

Quantities

When working with the white coating, smaller amounts are produced than when working with red coating. This is due to the fact that this mixture dries very quickly, and because fewer amounts are needed.

17. Named *charᶜineh* in Syria.

Preparing the mixture : fermentation, *takhmîr*

It is preferable to prepare the mixture the day before because the *ḥuwwâra* is very brittle and becomes very lumpy when it makes contact with water. By letting it bathe in water for an entire night, the lumps have time to dissolve. It is fermentation, *takhmîr,* which makes diluting the lumps possible. The soaking time depends on the clay's initial state and the dimensions of the extracted blocks. If it is extracted from the mountain in the form of large hard stones, it must be left in the water for more than 15 days. If the stones are smaller, two to three days is enough.

Before use, the *ḥuwwâra* must be reduced to smaller pieces (if it comes in stone form) until it becomes friable, then the workers should refine it and break up all the lumps inside it. Some do this by hitting it with a club, *daqq,* and sifting it through a 3-4 mm sieve. The workers keep a plastic sheet on the ground to prevent the soil from absorbing the water added to the *ḥuwwâra* and prevent the latter from turning reddish if it makes contact with the soil. They then cover it with another tarpaulin to protect it from any moisture or dew that might make it lumpy again.

If the *ḥuwwâra* has to stay in water for more than a day, barley straw, tebn chʿîr cannot be added as it might rub off, *ḥill*, on it and make it go a yellowish colour. It is only mixed with straw once it is ready for use and when workers are about to apply it.

Once ready, the mixture is wheeled to the site. The workers will also carry bags, *chwâl* of *tebn*.As work progresses, the women who are applying the plaster knead the mixture again by hand, gauging its thickness and adding hay if needed.

Preliminary stage

Before starting to apply the white plaster, the workers check the red plaster one last time for any cracks and holes that may have formed, or for plaster layers that have become detached. They review all of the walls to seal everything and eliminate defects that could have appeared during application and following the drying of the first plaster layer. The white coating also helps to seal cracks and crevices, *chuqûq,* and any peeled areas.

Applying white coating

Workers begin to coat from the top down, trying to smooth and level the surface. They pay particular attention to the hollows, and make sure to fix the joints between two different materials, such as the door and window frames, to the the clay walls where adhesion is not always easy.
Some will work the plaster with their hands; others wear gloves to move more quickly as gloved hands slide more easily. Others use a *meche*[c]. The white plaster layer should not exceed one centimeter in thickness. At this stage, the work must be very meticulous because the final appearance of the house depends on this final coating being level, straight, and free of imperfections.

Drying time

Once the white plaster is dry, after two or three days, depending on the time and the temperature, the workers begin to apply the finishing plaster, consisting of the same stone but in a liquefied form.

The cupola built in Taanayel, an area with a high level of rainfall, was covered with a thin iron net, *chabak,* after it was coated with the red clay. The workers then applied the white plaster over the *chabak*. This was the only way to preserve it from the harsh winters in the plain.

Finishing coat: liquefied *ḥuwwâra*

The finishing coat, in our case, liquefied *ḥuwwâra* is used to give a light, white, and radiant, *nâsî,* colour to the walls and facade of the house as mud plaster darkens houses; especially the interiors. The *ḥuwwâra* reduces this effect by bleaching the walls and making them brighter. When soaked in water, the *ḥuwwâra releases a very popular smell that erases other unpleasant smells, especially the smell of smoke from the brazier, kânûn,* when it is lit inside the house. It also has a filtering function used to oxygenate and cool the air and remove dust.

Admixtures

No admixtures were used for the *ḥuwwâra*.

Application

To be used as a finishing plaster, the *ḥuwwâra must be reduced to a liquid. To do this, the already crumbled stone is soaked in water for two to three days. On the day of application, workers fill a drum, barmîl,* with water, above which they place a screen with 3 to 4 mm diameter holes[18]. One of the workers, using a spade, fills this sieve with *ḥuwwâra* while another kneads it with his hands to crumble it, mars, and disaggregate it, *tafchîch,* as much as possible and to dissolve any lumps, *tdûb*. Workers regularly stir the liquid with a shovel, a big stick, or a large bowl in order to eliminate all the lumps. The *ḥuwwâra* is considered ready for use when its texture is completely smooth, and when its colour turns white like snow or, in the words of one worker, like yoghurt, while maintaining a sufficient thickness to facilitate its adhesion to the walls.

18. It is possible to let the stone melt slowly without using a sieve, but the latter accelerates the process.

Laying the *ḥuwwâra* : sprinkling and direction of application

The liquefied *ḥuwwâra* lis transposed into buckets to be sent to the site. On the site, workers start by sprinkling it (or watering, rach, according to the expression used) inside the house. They climb on the scaffold they installed earlier, and move on it as the work progresses. They keep a bucket filled with *ḥuwwâra* next to them, as well as a bowl. They fill it with liquid and throw it in the air in an attempt to reach the highest parts of the cupola. They work from the top downwards, since, if they start from the bottom, the top application might alter the part of the wall that was already coated by flowing downward, *salayân*.

A worker on the ground refills the buckets. Once the cupola and high walls are completely covered, they descend from their scaffolding to cover the accessible parts of the walls with *ḥuwwâra*, from the ground. They no longer need to throw the liquid in the air, but instead pour it directly onto the base, making this part of the process much easier. Generally, workers only use a bowl however in the event that they discover cracks that would have occurred after the coating had dried, they clog them with a sponge soaked with *ḥuwwâra*.

Once the interior is completed, and thus whitened, the process is repeated on the exterior of the house.

Despite all the precautions they take (protecting their heads with a plastic bag, waterproof clothes) to stop the flowing liquid pouring on them, the workers inevitably get soaked, and their faces, eyes, hands, feet, and clothes are covered in white by the end of the workday.

Some of our interlocutors mentioned the use of a pistol, or an iron machine with brushes inside to spray the finishing plaster in Syria however it seems that these practices have not spread.

Repairs or periodic renewal of body plaster and finishing plaster

Far from being the final step, the laying of body plaster and finishing plaster marks an important moment in the houses' maintenance path. Indeed, it is imperative to carry out constant and careful monitoring to keep the earthen houses in good condition. The inhabitants had to check the walls of their houses regularly to ensure that no crevices, holes or cracks have formed, and to intervene when necessary.

This intervention comes in the form of partial repair or renewal of the existing coatings. The performer decides on a case by case basis, depending on the condition of his house and the findings observed.

Periodic maintenance of body plaster

When the intervention takes place and repair frequency of the body plaster, varies according to three main parameters: the type of soil used, the rainfall pattern in the region, and emergency cases.

The frequency and the intervention and repair of the body plaster, varies according to three main parameters: the type of soil used, the rainfall pattern in the region, and emergency cases.

In Syria, the excellent quality of the yellow earth, which is very strong and extremely resistant, used for the main sealant, needs a renewal only every two to three years, (sometimes more than that). However, red earth coatings, such as those used in Taanayel, require an annual renewal.

The frequency of interventions also depends on the abundance of rainfall. The winter in Lebanon is more rigorous than in Syria, and the rainfall there is much more significant. Therefore, the coating of earthen houses is renewed on a yearly basis. Climate change, which is likely to occur in the coming years, and its repercussions that could induce game-changing results, should also be taken into account.

Apart from some rhythmic repairs, a coating that has deteriorated due to a harsher season and has not withstood the weather can determine the execution of an unscheduled repair. Therefore, it can happen that cracks suddenly appear in the walls or that water infiltrates through the *thyâkh* or the dome. Inhabitants must then intervene as quickly as possible and proceed urgently to the treatment of affected areas to protect the entire structure.

Intervention dates

Renewing the body plaster is usually done before the winter and the rains begin, around September. However, renewal must be undertaken relatively early to meet the required drying time. Emergency repairs that cannot be deferred are executed immediately. In the event that the damage is not a major threat to the solidity of the building, it may be postponed until the end of winter, once there is no more risk of rainfall.

Periodic maintenance of the finish coat

The finishing coat, *huwwâra*, witnesses the most regular renewals. Once a year, in spring, women proceed with what resembles the grooming of the house. However, the time of brushing the hûwwâra is ultimately and exclusively decided by the hostess, depends on her sense of order and cleanliness, some women do it twice a year.

« *Min hawer* », they say, to label this stage of cleaning but also of whitening, a symbol of seasons and the rebirth of life. Before starting, they take everything out of the house: mattresses, clothes, carpets, utensils, and take advantage of this operation to purify the bedding by exposing it to the sun. The emptied house is then sprinkled with *huwwâra* and left to dry. They then renew this operation from the outside, whitening the façade as well as the ancillary elements: low walls, planters, etc.

To this rigorous annual grooming, *tahwîr* operations would also take place, and before any major social life events which could give rise to the execution of an exceptional coating operation during which the wide-open house was prepared to welcome guests, parents and friends, who came to the event.

The whitening and deep cleaning of the house marked the rites of passage, whether individualor collective (engagement, weddings, ceremony of circumcision, return of pilgrimage),from dark winter

months to a new milder season. The time of *huwwâra* became a time of social sharing. During the operation, the mixture thrown on the walls fell back and splashed the coaters, whose face were smeared and completely covered with stains. However arduous, this stage provided great cheerfulness and joy, especially for children to whom it truly was a game that foreshadowed a period of festivities. They also played an important role since they participated in helping the women in various ways: transporting objects or water, dilution of *huwwâra and so on*.

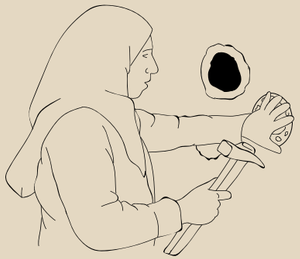
To reach the higher parts of the domes, women used ladders. When there weren't any, they would not risk climbing up, instead they threw the liquid as hard as possible, from the ground. Their difficulty in reaching the roof peak explains that, in spring, these Syrian villages which hosted cupola houses were only partially coated.

Decorations and paintings

Indigo, *nîl*, was once used to brush the lower parts of the house walls. However, industrial paint later replaced it and was also used for the doors of the houses (which were traditionally left untouched), and to apply some figurative decorations, especially flowers, on the walls.

In the Taanayel house, once the coating stage was completed and the mountings were dry, the workers covered the lower parts with indigo, carefully monitoring that the right dosage was applied, as too little a quantity would have rendered the blue colour, white.

It was once customary to beautify the houses with earthen decorations, to elegantly cover the interiors that were often left bare. These ornaments quickly became an intrinsic part of the houses' walls. The Taanayel cupola house does not have such decorations as these would later be concealed by the shop's furniture and products. Nevertheless, plates, cups and fragments of mirrors and glass were embedded in various places, such as around the parabolic part of the arch and the window edges.



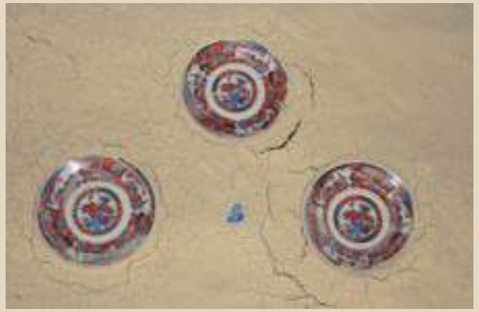
Method of inserting an object:

• With a hammer, crack the place where the object is to be laid. The cavity's depth is relative to the dimensions and the thickness of the element which, in the end, must be lined up with the wall. In general, this depth reaches 3.5 to 4 cm.

• Moisten abundantly, in case the object is embedded on already dried walls. Wallpaper the hollow with coating.
• Arrange the item and insert it in with the fingers or the wrist.

• Coat and smooth everything around it.

Do not be afraid to stain a piece of porcelain or a mirror. As soon as the coating is dry, the item can be easily cleaned.



Chapter 9

Floor covering

In Syria, the builders use *arḏiyeh,* a hard and very solid clay soil, called *joṣṣ*, similar to the one used in the construction of bread ovens. It is harder than the one with which mud bricks are made. In Lebanon, it is possible to find soil with the same characteristics in Britel, Ersal region, and in the village of Nabi Chit, localities in the northern Bekaa region.

Usage of *joss*

The *joṣṣ* is mainly used to seal the soil. This treatment allows repeated rinsing and washing of the floors with large jets, as is the practice in the region, without any risk of water absorption.

It also helps protect the bottom of the interior walls, which are coated at a height of about 70 cm, from water infiltration. The workers avoid climbing higher, because the installation of the joss then becomes more and more difficult.

The *joṣṣ* was also used to cover the circumference of the ventilation openings. During periods of extreme heat, these openings were sprayed with water to cool the air inside the home. A person standing next to these openings, which act as air conditioners can enjoy the cold air, they let in.

Furthermore, just like the *ḥuwwâra*, the *joṣṣ* has a good smell, especially when water is poured on it.

In order for the *joṣṣ* to have the necessary characteristics for its use and functions, it must go through a combustion process that is generally done by women.

Method

Provenance of the soil

As much as possible, the soil is extracted from the land near the construction site. In the Khanasser region, where the domed houses exist, the *joṣṣ was abundant; it was enough to only have to dig 2 to 3 cm under the vegetal layer to reach the white soil. In the event that the joṣṣ* was not found nearby, the inhabitants had to bring it from another location.

Sieving

Before proceeding with the burning, the soil must be very finely sieved. For that, people used a large sieve, often assembled from whichever materials were available.

Combustion

When the soil contains *joss*, the masons use spades, to build a pit which must be narrow enough for the masons to be able to proceed with the combustion process, whilst still standing far enough away. This is imperative so they do not trample it, thus preventing the mixing of the ashes and sieved soil. Also, it must not be too deep for the fire to reach all of the *joss* which is why they opt for a pit measuring 1x1 m in length and 10 cm in depth.

In the event that the *joss* is brought from another site, a pit with the same characteristics is laid out and the soil is poured over it.

Before starting the combustion process, the masons must make sure they eliminate all the dirt from the soil on which they work, it must be very clean. The *joss* is then spread evenly over the entire surface of the square.

Combustible

The fuel most commonly used for this process is fertilizer and sheep or goat manure, called *zebel, sawâd* oe *baʿr*. Some testimonials mention the use of other materials, in fact, any handy material that is likely to be recycled and burned, such as pieces of rags, fabrics, empty bags (jute, *chwâlât*, or plaster bags, *jafsîn*) and even old tires, can be used.

Quantity of fuel

The amount of animal fertilizer used depends on the size of the pit, in general a layer of 5 cm is applied. In order to optimize the combustion process and to start the fire more easily, fine straw is mixed into the manure or placed over it.

Duration of combustion

The burning time varies and depends on the weather conditions and the wind. In some villages, builders let the mixture burn for one whole day whilst others leave it for two, three or even five. The majority refer to fires which last for a week, and sometimes even ten days.

The number of fires is variable. One is usually sufficient to get the desired result; however, several batches could be necessary. When the first batch of manure stops burning, another is added, and the process is repeated up to three times.

In order to ensure the success of the operation and to achieve the desired result, the soil and the fertilizer must burn together very slowly, just like cotton burns. The soil should not "catch fire" but burn gradually over a low heat. It is crucial that the mixture "takes", and that the soil cooks *tastawî*, therefore, it is necessary to let it ripen first *ṯandoj,* These are words of the builders themselves.

Result

Combustion ensures the process of solidification of the soil that becomes as hard as concrete.

The evidence that the operation has been correctly completed and that the mixture is mature enough is the colour change of the *joss*. Initially white, after combustion it has a brownish tint that can turn gray or blue. The person who carries out this operation will remove the ashes to check the colour of the *joss* on a regular basis. The colour change is the ultimate proof that it is now ready to use.

Some use the expression *yinaḥess* to say it has become hard like copper, *nâḥâs*, thus describing the final texture.

Extraction

Once the fire is completely out, the mason waits for the ashes to cool in order to remove them and extract the soil. To do this, they use a shovel or a small wooden lath to collect the product by taking all the necessary precautions to prevent it from mixing with the ashes in order to obtain a pure and clean soil.

When the builders do not want to use the soil immediately, they put it in bags and store it in a dry place, far from any humidity. However, if they wish to use it on the field, they mix it, *jabel,* and knead it, *dalek,* with water (it requires more water than cement). They perform this operation preferably in a basin, *tochot,* made of iron or aluminum, so the soil is not contaminated by any external impurities. They add just enough water so that the mixture does not dry too fast whilst they prepare the parallel ground, by compacting it with small stones. Both operations must be simultaneous to prevent the mixture from hardening and becoming unusable. Once the ground is ready, the workers pour 5 to 10 cm of the obtained mixture and level the surface with the *meche*[c.c] . It dries more quickly than cement and only takes one or two hours to dry. They wait 24 hours before stepping on it and, in order to obtain smooth floors, they add slices *barch*, of Arabic soap to the water for the first wash. Sometimes industrial soaps can be used as an alternative to Arabic soap.

Difficulty reproducing certain techniques

The *joss* experience is an example of the difficulty of relocating a particular technique, and still managing to reproduce it. The challenge was to find soil that had exactly the same characteristics as the one used in Syria. Our first experiment with local soil was not successful because of its incompatibility, and we were forced to finish the work before winter came. We therefore decided to coat the cement floor, a solution used in Syria and recommended by the Syrians themselves. We also renewed the same experience in the spring and the result was conclusive.

Chapter 10

The cupola house of Taanayel: a witness and mission house

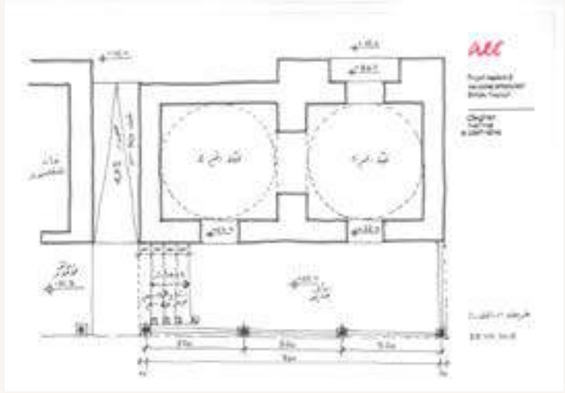
In the Taanayel site, we achieved our first objective and successfully constructed a double cupola house. The Taanayel cupola house made of mud bricks has a rectangular shape, with a width of 5.25 m and a length of 9.75 m. The dimensions were constrained by the existing space, which is limited by *arcenciel*, caravanserail on one side, and a canal on the other.

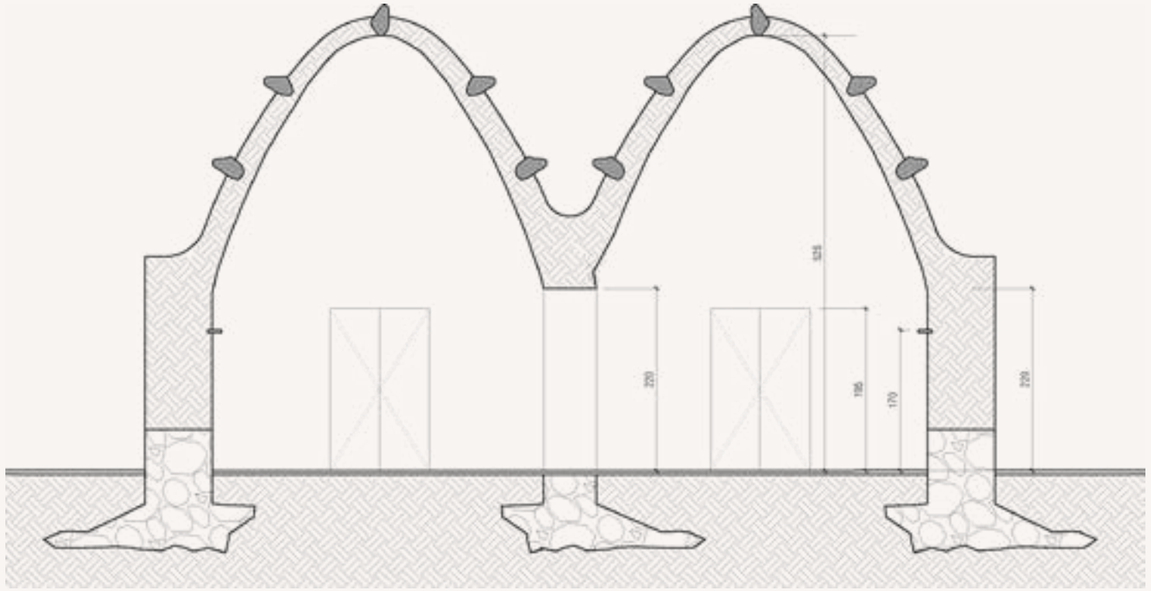
Initially, our main goal was not to build an inhabitable accommodation, nor was it to produce a replica of a still witness house. Instead, it was mainly about interpreting the accommodation as a space with functions to complement the caravanserail and the ecolodge. With a porch preceding its entrance, the building is composed of a cluster unit (multicellular unit) capped with two corbelled cupolas on square bases of 3.75 m on every side. The first cell has opposable doors, facing both north and south, and a side window. The second one has a door facing north and two windows with equal dimensions. While tradition says no more than one door should be drilled in the same cell, we decided otherwise in order to adapt it to the needs of the activities in the house now.

The first cell is a partition between the valley with chaotic urbanization and the interior space. The latter, with the caravanserail and ecolodge, forms a characteristic "island" at Taanayel of the traditional architectural type of the region. Therefore, the house creates a threshold between the two different spaces. The passage underneath the cupola is a transitional space which gives visitors time to cut their links with the outside world, before being introduced to an isolated place. Another porch has also been added in front of this unit's south door in order to highlight the entrance. Although it is not in conformity with already existing designs, it is used to define the entire island's main entrance. The north door allows access to the heart of the project through a gallery *rwâq*, which is an extension of the caravanserail. This type of gallery is typical in the Beqaa houses, and is an added feature in a Syrian houses' design. It ensures unity across the interior facade and harmoniously integrates the house into the overall construction.

The second cell serves as a shop that sells a wide array of *arcenciel* : products: from ceramic items manufactured by the association's volunteers, to winter food supplies made by on-site trained women, and the intra-muros published books.

Now the cupola house has been rendered very useful thanks to its dual functionality. Mainly whilst continuing to be of service to the sustainable development programme of *arcenciel,* it has also now turned into a living place that will stand the test of time.





Insertions into the existing design and other additions

In order to attain our goal of integrating the cupola house onto the site, a few further additions that were new to the traditional Syrian designs, were implemented. For example, the fore mentioned entrance porch, and the *sfâr,* a wooden roof edge which is crucial to shelter the construction from the heavy rainfall in Lebanon. The *sfâr* is constructed from a range of beams, each 55 cm long. Above those small beams, the masons fixed sheet-metal plates with nails that they covered with mud bricks and then a fine layer of cement.

Similarly, the external wooden gallery, *rwâq,* has been built on the northern side, as an extended part of the caravanserail's gallery, in order to ensure the integration of the already existing units on one hand (notably with the adjacent khân), and to spare the visitors from the unfavourable weather conditions on the other.

To set up this gallery, 3 m beams were arranged on a bigger one, supported by 4 columns topped by capitals. Above, the masons set up wooden planks which have decorated edges. They then covered the entirety with a layer of cement.

Before they can be used, the beams have to be pealed, dried and sanded. The parts that aren't visible once installed, are covered by tar; the visible parts are oiled and often painted.

Since the place witnesses a large number of tourists, and a lot of children, we have equipped the gallery with a railing for security purposes.

With these additions executed, the cupola house is now complete. It is where it should be whilst also still resembling the previous constructions which have taken place on the site.

Ideally, mud houses must blend in with their environment and surroundings rather than being isolated and preserved, as is currently the case. However, years of chaotic urbanization in the region have probably led to the point of no return with a completely deteriorated environment. Whilst being aware of the limits of our experimentation, we hope these architectural techniques will inspire people to build spaces that, by showing what was, do not damage the environment, as much as the current methods of construction do.

The legacy house

Since the outbreak of the Syrian war, the coerced coexistence between the refugee population and host communities have forced thousands of Syrian families to seek refuge in Lebanon. The growing tension between the two national groups rendered this coexistence arduous. Faced with this crisis and to help calm tensions, *arcenciel* aspired to implement -as do other associations - projects that gather both parties together.

Since its early days, *arcenciel* has centered its mission around the welcoming and inclusion of others. The association's charter stipulates that any person enduring a difficult situation should be able to benefit from the hospitality and services his/her situation requires, without subjecting them to unfair discrimination. Believing that with difference comes strength, *arcenciel* endeavors to promote diversity and pluralism across all its areas of intervention and in all its programs: Human (youth, social, rehabilitation, employment) as well as Earth (environment, tourism, agriculture).

Its latest program, the culture program, was naturally the bearer of this diversity. It advocates the protection and preservation of the numerous cultures of this small country which was born from the convergence of populations from diverse origins.

The architectural richness of Lebanon, not with standing the country's small size, conceals a wide range of architectural styles reflecting the country's geological and geographical characteristics as well as its lifestyles, contributing further diversity that needs to be highlighted and protected.

arcenciel's culture programs first interventions resulted in several mud brick constructions built according to the local techniques in Lebanon. The program has now extended its discovery, exploration, and heritage preservation of the region's construction traditions. This is why the Syrian cupola house construction project, in the Beqaa, was perfectly in line with the overall mission of defending and promoting the Middle East's cultural pluralism.

Yet, in this turbulent period of regional history, the construction of a home bearing such identity was negatively perceived by some. This was reflected in negative reactions and comments concerning the project. This project had no intention of implementing an architectural style which was unsuited to the country's climatic conditions. The objective was simply to pursue and enrich the years-long experimentation in this vernacular architecture known as earthen construction.

The only answer to those doubting the merits of this project was to recall that mud brick construction techniques are a cultural trait, widely shared with our Syrian neighbours. Indeed, cultures are essentially molded in their borrowings from other cultures. A diachronic overview of the history and genesis of an inheritance, whose identity is considered undeniably Lebanese, will reveal the various influences composing it. Many traits, now integrated into our local culture are the result of external inputs and we are not longer able to recognize their "foreign" character.

With all the questions and debates the cupola house raised, the cupola project evolved into a mission we did not foresee. It was unwillingly destined to evolve into a home, to witness the welcoming of others and their culture. At a time of identitarian closure, it is more crucial than ever to abandon such dangerous paths and to preserve the element the house puts at the core of its existence: hospitality. Therefore, Taanayel's cupola house becomes, like a *maḍâfeh,* a place to welcome visitors that always existed in Syria's communities, however modest they may be.

Conclusion

Houda Kassatly

I. An architectural technique on life support

At the beginning of this book, we mentioned the current state of earthen and cupola houses and the impact the Syrian war has had on them. The armed conflict has played an undeniable role in the abandonment of this architecture, but it would be wrong to let the war bear the sole responsibility for the changes and transformations that have affected this millennial tradition. While in other parts of the world, thanks to the increase of environmental awareness, earthen houses are acclaimed for their ecological benefits, in Syria, long before the current crisis, these homes had already begun to fall in a sharp decline. Implying a strong stance of poverty, these houses lost their value in the eyes of the inhabitants, who aspired to adopt new construction techniques. Many people had already taken that step whilst others were waiting for their financial conditions to improve before following the trend.

At this turning point in the history of this architecture, and while its future survival is uncertain, it is necessary to analyze the situation, taking into account the opinion of the very people who lived in cupola houses and are the most concerned with its possible revitalization.

Industrial materials and shortages

As soon as they became available, industrial materials were quickly adopted due to a number of situational and socio-economic factors. These materials were practical, easy to handle, and reduced the number of workers needed, offering an alternative to the arduous construction and repair of earthen houses that requires a more extensive workforce. The massive distribution of these materials was also imposed by shortages of straw: before the war, builders never had to buy soil which was abundant but they still faced the scarcity of the very thin straw due to mechanization[19] and a severe lack of water after many droughts. Moreover, the loss of the last experts (due to aging, death and forced displacement) who specialized in this particular technique and had the precious know-how, fueled by the lack of demand led to a turning point in the history of this architecture[20]. The specialized master masons' numbers had already dwindled before the start of the conflict. It is quite exceptional nowadays to find a person who still has the knowledge to carry out this activity. As the years passed, some of these experts have died; others are too old and no longer had the physical strength to do this hard work. Furthermore, most of them have been forced to leave their homes, flee their countries, and their traces were lost on the road to exile and internal displacement. In the meantime, a new generation of masons has emerged – masons who do not know much about this heritage and are strangers to this technique and therefore unable to take it over.

19. In fact, the use of mechanical harvesters, while preventing any reach to the straw that is usually manually harvested with the scythe and the sickle, has deprived builders of an important construction material. The straw that is being extracted nowadays is neither suitable for the brick mixture, nor for the preparation of coatings.
20. With less demand on similar constructions, some masons who master the technique have switched to concrete construction.

Rural exodus

The rural exodus towards the big cities in Syria is a major factor that led to the abandonment of earthen materials which have now been replaced by concrete. The cupola houses were not occupied for a big part of the year and were therefore no longer inhabited except in the summer. More people living in the cities meant more people were familiarized with urbanism and new practices of living.

Equally, the migration of a large number of men to neighbouring or far countries in order to find employment, has put a huge strain on this architecture. Young Syrian men, often toiling as construction workers, learnt to build cement houses instead and now wish upon their return home to reproduce this type of construction, which gets strong approval from their

Women and disaffection for earthen architecture

This disaffection towards earthen architecture has been largely expressed by women, who play a central role in its gradual abandonment. They are the main "opponents" of earthen houses as restoration, plastering, and embellishment works were traditionally delegated to them, and they bear the heavy weight of their homes' repair. This explains why many of them loathe this task and dream of modern apartments and their alleged comfort that they have heard of through the accounts of their husbands, brothers, fathers, and especially from watching soap operas on TV. Tired and discouraged by the ongoing and necessary work to maintain their traditional housing, women now want to live in cement houses that spare them all the tedious work. They prefer houses that free them from the weight of painful and periodical interventions. They see the contrast between the fragile materials and the recurrent degradations and a solid house that causes no concerns and spares them the constant fear of bad weather as was the case every winter, when infiltrated water, despite all the efforts to avoid it, caused damage and exposed the houses' extreme vulnerability.

Moving with the times

We must also consider the need to feel that one is keeping up with the times. "Earthen houses are outdated", many women say. Maintaining this construction is akin to refusing to accept the world's modern trends. It also means overlooking the aspirations of a new generation who wants to distance themselves from a type of habitat deemed old-fashioned. By opting for the concrete blocks, new builders bring a breath of fresh air and modernity that goes hand in hand with the desire to break the image of a population frozen in time, living in a previous age and who are disconnected from the contemporary world. The negative perception of these houses and their inhabitants has created an association between earthen constructions and underdevelopment, which has led to discomfort. The inhabitants wish to escape this by opting for more modern constructions. To build and live in cement houses is to be seen as people who have left behind an archaic way of life which they have decisively turned their backs on.

When resembling your neighbour turns to a need to differentiate

Another factor must be taken into account: now is not the time to comply with one's environment and surroundings anymore, now is the time to stand out and be different. In the past, people's houses were similar to those of their brothers, close family, and neighbours, which translated into a harmonious exterior ensemble. It was only the interiors of the houses that allowed one to assert their individuality. Nowadays, everyone is trying to distinguish themselves from each other. Families do not wish to identify themselves with their surroundings anymore, but rather from a far away place where the grass seems greener, namely, in concrete houses, in those dreamy apartments where the city people live; the same apartments where their soap opera heroes live and that their men can now build. Just like anywhere else in the world, a house in Syria is a mirror of migrant success, and is tangible evidence of the acquisition of a new social status, a clear sign of wealth. Even if the new constructions often stand out in the landscape, ill-suited to their surroundings, they are envied by everyone and remain the barometer of a financial situation which everyone aspires to. Since building such houses requires money, the pressure grows on the men who find themselves with no other choice but to travel abroad to work, then come back to their villages to build with concrete.

« We have built a house with cement and concrete blocks, but nothing compares to a cupola house, the latter is far better. »

Advantages of earthen houses vs. the sake of appearances

However, the transition to concrete was not always easy. Many residents complained about the lack of comfort in cement houses and their inability to cope with climatic constraints: ceilings that store and radiate heat until late into the night, not to mention the additional energy costs generated by the adoption of industrial materials. Heating a cement house is indeed much more expensive than heating a mud brick house.

Whether or not they have abandoned earthen houses, many people recall, often with nostalgia, the benefits of these constructions: the pleasant smell they spread, the natural and healthy qualities of the materials that they are made from and protection against diseases, the aesthetics of their cupolas and the colours of their coatings. But the highlight of all these unanimously praised benefits remains the guaranteed thermal comfort, thanks to the thickness of the earthen walls, which act as isolators and which maintain moderate heat in winter and a pleasant freshness in summer. The lack of windows and the very small openings of the cupola houses undeniably protect the inhabitants from the extreme temperatures outside. It is sufficient to keep the door closed to enjoy a pleasant temperature, to the extent that the use of a blanket in summer is sometimes necessary.

After admitting to all these benefits, partaking in the reconstruction of the socially-denounced earthen houses would seem like the obvious next step. Nevertheless, despite enumerating their various advantages, most people remain adamant that they should abandon the cupola constructions. An older man told us a story on this subject which clearly illustrates the extent of this contradiction: under social pressure he built a cement house to mark his professional success. Yet, he still sneaks out quietly, every night, like a thief to his old, still-standing mud house to enjoy the quality of sleep it offers. The contempt for earthen houses is so serious that he does not dare express his preference for them. Appearances win over the predilection of this daunting type of architecture. Awareness of the benefits and social considerations remain two irreconcilable issues. Just like Amos Rapoport said in his book "For a housing anthropology"[21] , cultural factors impose solutions that are not rational from the climate's point of view, but are in line with social considerations (discontent with the way of life, denial of the lack of convenience of these dwellings and the luxury of innovation).

Marital practices also measure the degree of this devaluation. From the point of view of Syrian families, the only prospective suitor likely to get his marriage proposal accepted is the one who can offer his future wife a habitat worthy of her, namely a concrete house. Many fathers refuse to give their daughter's hand in marriage to a man who only has an earthen house to offer, a sign of an unstable financial situation and a difficult life ahead. Sparing their daughter this difficulty becomes the ultimate requirement of parents.

All of the above clearly explains why earthen and cupola houses began to gradually disappear from the landscape of certain regions in Syria about fifty years ago. They were initially replaced by mud brick houses with flat roofs that cover a square or rectangular room, *dâr*, Then, cement and concrete blocks took over. In some places, the cupola houses, having lost their aura, only remain standing because they have been converted into stables or warehouses.

21. A. RAPOPORT, *Pour une anthropologie de la Maison*, 1972, Bordas.

The war then accelerated the process of depredation and depreciation. The jolts and shocks caused by the conflict contributed to the widening of an already existing gap. War therefore became yet another factor to not only destabilize the situation further, but to become the breaking point, a step too far that turns it into a decisive point of no return. Even though this construction technique could withstand the pressure, as shown by the large settlements of pre-conflict cupola houses in Syria, it is now running the risk of being completely eradicated.

« I am a daughter of the earth. »

Exile, uprooting, and breaking

If the most visible effect of the Syrian civil war on earthen architecture is the physical destruction of earthen and cupola houses, the forced displacement of the inhabitants is certainly a decisive cause of their abandonment. This displacement has its consequences, namely the detachment of an entire generation from its homeland and being brought up in total ignorance of the architecture so intimately related to their birthplace. The effect of these years of disconnection will definitely have irreversible consequences on the future of their heritage. To live in these houses is to have memories and bonds that are established from an early age and memories that awaken all the senses. The mixing of mud, the participation in various stages of construction, the visual harmony, the silence of a house that softens noise[22], the proximity of silos giving a glimpse of cherished dishes, are all such important memories, they can never be completely erased. However, above all, it is the scent of the *huwwâra* spreading throughout the house during the plastering renewal operation that remains, in the unanimous opinion of our interlocutors, the ultimate memory, just like Proust's madeleine. It is what makes many women say: "He who has lived in an earthen house cannot live in another type of house"; or: "At home, everything is made of earth. I am a daughter of the earth."

Unlike the older generations, whose strong links to this technique are weakening due to their expatriation; young people born in exile never had the opportunity to get attached to it. They grew up elsewhere and did not get to experience a childhood steeped in earth and mud. Beyond this awakening of the senses, young refugees are also deprived of the education that their homeland house provides, exposing them, since their childhood, to the practices, rules and restrictions, codes of sociability and hospitality, respect of hierarchical relations, social classification and many other parameters[23]. Cut off from their roots, they have established new ones in other places and other cultures. That is why, if they return to their country of origin and in addition to the unavoidable difficulties of re-adaptation, they will certainly face the challenge of identifying with a completely new way of living.

22. An earthen house is called Beit Akhrass (mute house) in Arabic
23. See Jacques Pezeu-Massabuau's book « Habitat ; code, sagesse, libération », Editions Parenthèses, 1999. This is why under the most precarious of shelters, refugees try to reapply the pattern of their habitat, even though they often collide with physical constraints as well as the limits of their status in the country of exile.

The project of building a dome: safeguarding and inspiration

The previously mentioned challenges expose the complexity of the situation. It is within this specific context that we chose to set up our site to resurrect this constructive technique with the help of masons and master masons. Our goal was to build up a body of information as complete as possible and to make it readily available to all.

At this stage, we consider this project, both in its mission and its stakes, to betruly justified. Its necessary implementation cannot be questioned. This does not preclude evaluating our commitment to promoting the cupola architecture in light of the reality on the ground. In fact, given the current data on this construction technique, there is a great risk that we unwittingly participate in embalming it[24]. After all, the regions where the cupola houses were born are now empty of inhabitants and are at risk of losing their true vocation, since they are deprived of the social fabric and the human environment which gave them their reason to be. What is, therefore, the future of this technique? Is there a risk we will see these houses turned into eco-museums or guesthouses, who's sole purpose is supporting tourism-oriented projects instead of their original functionality, which is to be inhabited?

« Ce n'est pas du patrimoine, ce sont nos maisons. »

III. The resurfacing of cupola architectures: pastiche or habitat?

The danger of heritage patrimonialization

Although the idea of freezing this architecture was never our plan, there is now a danger of this. A remark made by one of our Syrian interlocutors illustrates this impression more accurately. While we were talking about these architectures in terms of heritage and their need for protection, he objected with a tone wavering between astonishment and annoyance, stating that, in his eyes, this was not a matter of heritage, but rather his home. The risk of converting a living technique into an object of "patrimoine" is therefore real. "Objects, monuments, and remains are acquiring a value they did not have, even when they were in use, back when their contemporaries (those who used them, lived in them, or passed through them) did not even notice them. »[25] If war causes a gigantic breaking, and triggers a vulnerability that brings out the matter of heritage[26] and, by extension, shifts the value of these homes, we, as heritage makers, also risk playing a role in this shift by assigning a "heritage emotion" and an "aesthetic delight »[27] to this type of habitat.

24. F. CHOAY, *Pour une anthropologie de l'espace*, 2006, Seuil, p. 272.
25. F. HARTOG, *Patrimoine et histoire le temps du patrimoine*, dans ANDRIEUX, Jean-Yves (sous la direction de), *Patrimoine et société*, Rennes, Presses Universitaires de Rennes, « Art et société », 1998, p. 360.
26. HERVOUET, *Patrimoine et habitat social* dans KAZNADAR Chérif (sous la diréction), *Le Patrimoine, oui, mais quel patrimoine?* 2012, Internationale de l'imaginaire, N° 27, Babel, p. 360.
27. G. ZOUEIN, *Pour qui et pourquoi patrimonialiser ?* dans KAZNADAR Chérif (sous la direction), *Le Patrimoine, oui, mais quel patrimoine ?* 2012, Internationale de l'imaginaire, N° 27, Babel, p. 62.

To avoid danger, one must consider the possibility of the resurfacing of this construction technique in post-war Syria. It is clear that question about the future of cupola houses and about the future choice of habitat are closery related to the conditions of the inhabitants' return. While the ceasefire in some areas does not guarantee return, still burdened by multiple obstacles[28], the possibility of return stil emerges. It is expected that some families, currently living in a dead-end situation in their places of exile, should choose to return to their villages where they will face a major challenge: rebuilding their daily lives. They will certainly not be able to go back to their pre-war life before reestablishing a link to their past and setting up a dwelling. Having a roof over one's head remains the first condition of the resumption of a normal life. They will then have to confront the clean slate that awaits them. Because of the fragility of mud houses, it will be difficult to consider the restoration of their homes that have been abandoned for nine years or so.

It is still difficult to envision the type of habitat these families will build. Because of the reasons previously enumerated, and taking into account the breaking of the transmission chain between master masons and new learners, we can state that the return to earthen constructions remains hypothetical, even improbable, and that the inhabitants are in the process of turning the page definitively on this architectural history.

This presumption cannot, however, be categorical. Even if it seems difficult to project ourselves into the future, we can nevertheless formulate some possibilities, while keeping in mind that they might turn out to be wrong.

We will start from the observation that, in the huge reconstruction of Syria, the future of the modest cupola villages will certainly not be an issue and will probably not be the object of debates and challenges certain to arise in the country's big urban centers[29]. That is why it is likely that, when the government gives the right to the inhabitants of the cupola villages to rebuild their regions, they will have a choice of which construction techniques to use. Besides, since there is no guarantee that the government will provide them with the materials needed to rebuild their homes, the return of these displaced people, broken by years of exile and deprivation, will undoubtedly be done under difficult financial circumstances and the choice of materials will depend on each refugee's means. The wealthier will be able to procure concrete blocks and industrial materials, while the others, faced with the urgency of their relocation, will have to resort to obtaining the least expensive resources available to them. They will therefore get materials from their environment, just like the previous generations of builders did before them. Mud, which is accessible and more importantly free, will become the prime option to build the essential roof, the main prelude of their struggle to regain a measure of normality. It will be a matter of survival for these families, many of whom have already suffered huge precariousness for years. While most of them have lived in tents and in makeshift shelters, earthen houses will, without a doubt, be a beneficial alternative for them.

28. Area ranked as a military zone, a forbidden access, the impossibility for many Syrians in exile to return due to the compulsory military service, the total absence of infrastructure (such as access to water, electricity, services, schooling ...), political fear.
29. The dilemma between the risk of starting with a clean slate and the repair of old houses.

Regardless of their choice, original inhabitants will face the same challenges: readapting to their old lives and most importantly introducing the youngest among them to an unfamiliar environment. In order for this adaptation to take place in the most positive way possible, it is essential that they contend with their losses, whether triggered by war, societal changes, technological developments or other factors. Above all, they must take into consideration the consequences of their losses and the associated changes, including changes in mentalities, adoption of new practices and rules and new requirements for comfort and privacy.

The success of the construction projects depends on the preference of the future inhabitants, because it is quite legitimate to refuse a house that one considers unsuitable or dysfunctional. Hence, the importance of vernacular architecture becomes apparent: The vernacular architecture is done without architects and is carried out by those who will use it and, therefore, will have a direct influence on the design of their housing. In this kind of habitat, the future owner of the house and his whole family partake in the construction. Together, they devise the solutions that allow the house to accommodate the needs of everyone including the young and the old, those who left or remained because of the war those who lived in concrete houses or tents or in even more precarious settlements. Last but not least, this habitat must meet the demands of the women. The local community as a whole will have to avoid considering these houses as immutable sanctuaries and look for ways to design functional homes where innovation and adaptation are in line with the wishes and needs of all. It is only then that the coherence between the needs of contemporary life and this habitat will be ensured, that the dangerous option of "living in heritage" will be avoided, and the houses will be a place where all the family members needs are answered.

Once the project of the Taanayel cupola house was completed, the master mason on the site, and co-author of this book, decided to return to Syria with his extended family. He did however wait for the publication of this manual before leaving so he could refer to it if needed in the future. The situation he will face upon his return will determine his impending choices. The future will reveal what he will do with this manual, created from the Taanayel cupola house construction site. Will he reclaim this construction technique and commit to living in a traditional home? Will he commit to building a traditional house, or will he use some of the old techniques and blend them with more modern methods? Will he build a cupola roof, or a flat one which might be more appropriate for contemporary living? It is probable that this site, which has been a place to exchange ideas more than a technical spot, will provide him with inspiration. In the dialogue initiated by this project, the environmental issues that one can no longer ignore have been brought up. The earthen architecture, supported by this construction manual, may then be reconsidered in light of the depletion of natural resources. The inhabitants will be able to find answers to the energy crisis of our time and if combined with the skills of the elderly; they should consider earthen architecture a potential solution. The adoption of an energy-efficient habitat could be, in retrospective, a very wise choice. Similarly, as we mentioned

above, the abundance of earth material and the low cost of its implementation could become the solution to the acute housing problems that the exiled populations face. The adoption of earthen houses does not have to reject new approaches and contemporary practices or slow down the rise of modernity. This construction technique should not be ascribed an erroneous immutability, but should be remodeled, rethought, and reinvented under the responsibility of its builder-inhabitants to let them live in a way that responds to their modern-day values and ideas. This should lead to the renewed relationship between the inhabitant and his house. To live in a customized and redesigned earthen house in sync with the modern world will no longer be seen as an undesirable option, but rather the preferred choice.

The inhabitants of the villages in Northern Syria, heirs and custodians of this earthen construction technique have transmitted it to us for safe-keeping but ultimately, it's their right to have the final say. They may choose to develop it, to reproduce it or in part, to remodel and adapt it or perhaps they will abandon it altogether. They could also be inspired by the numerous innovations applied to this material throughout the world, and reconsider this technique as a viable and sustainable option.

It remains certain that without their involvement, any project intended to exist long term, will inevitably be doomed to fail.

Annexes

Annexe 1

Constitution of the team

The team

On the construction site of the Taanayel domed house, a permanent team - between architect, ethnologist, master masons, masons and laborers - was at work. She was assisted by many other people, coaters, decorators, architects, students ..., not to mention the children who accompanied their mothers on the site as they were in their villages of origin, they participated at their level at construction.

Some have been consistent and have become largely involved in the project. Others made sporadic passages. But each, in its own way, has brought a brick to the building and left its mark on this common work, thus contributing to the success of the project.

Architect

Fadlallah Dagher

Team leader

Emile Saadé

Advisor

Youssef Hamdo

Foreman

Adnan El Khodr

Ethnologist

Houda Kassatly

Masters masons

Issa el Khodr
Ahmed el Hussayn

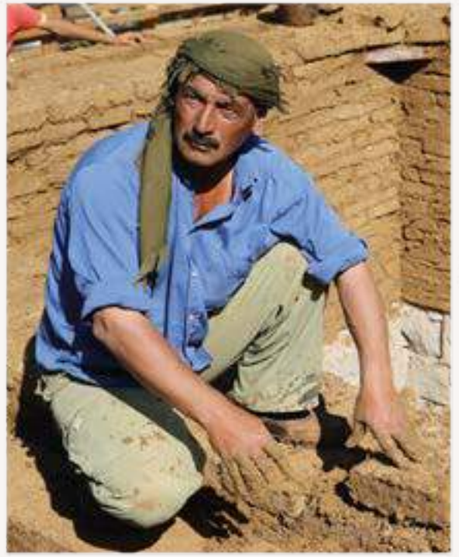
Masons and maneuvers

Abed el Abid
Bachar el Alawi
Turki el Alawi
Abdel Karim el Ibrahim
Amine el Issa
Bassel el Issa
Hasan el Issa
Mahmoud el Issa
Mohammed el Issa
Nayef Izzo
Majd el Khodr
Massab el Khodr
Khaled el Nouaysser
Ghazi Zeaïter
Saïd Zeaïter
Ahmed Zeitoun











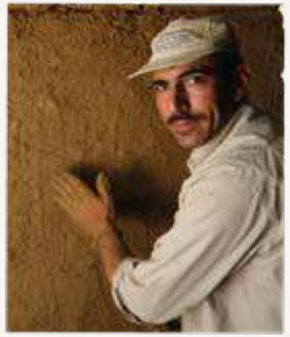












Hanane el Abdallah
Mohammed el Ahmed
Mariam Charmoukh
Zahra Charmoukh
Amina Chehadé
Hayat Chehadé
Hala Habache
Yara el Hashem
Mounira Houran
Angèle Keserwany
Aya el Khodr
Karim el Khodr
Nadima el Khodr
Diala el Khodr
Denice La Torre
Ftaim el Moustafa

And many more...











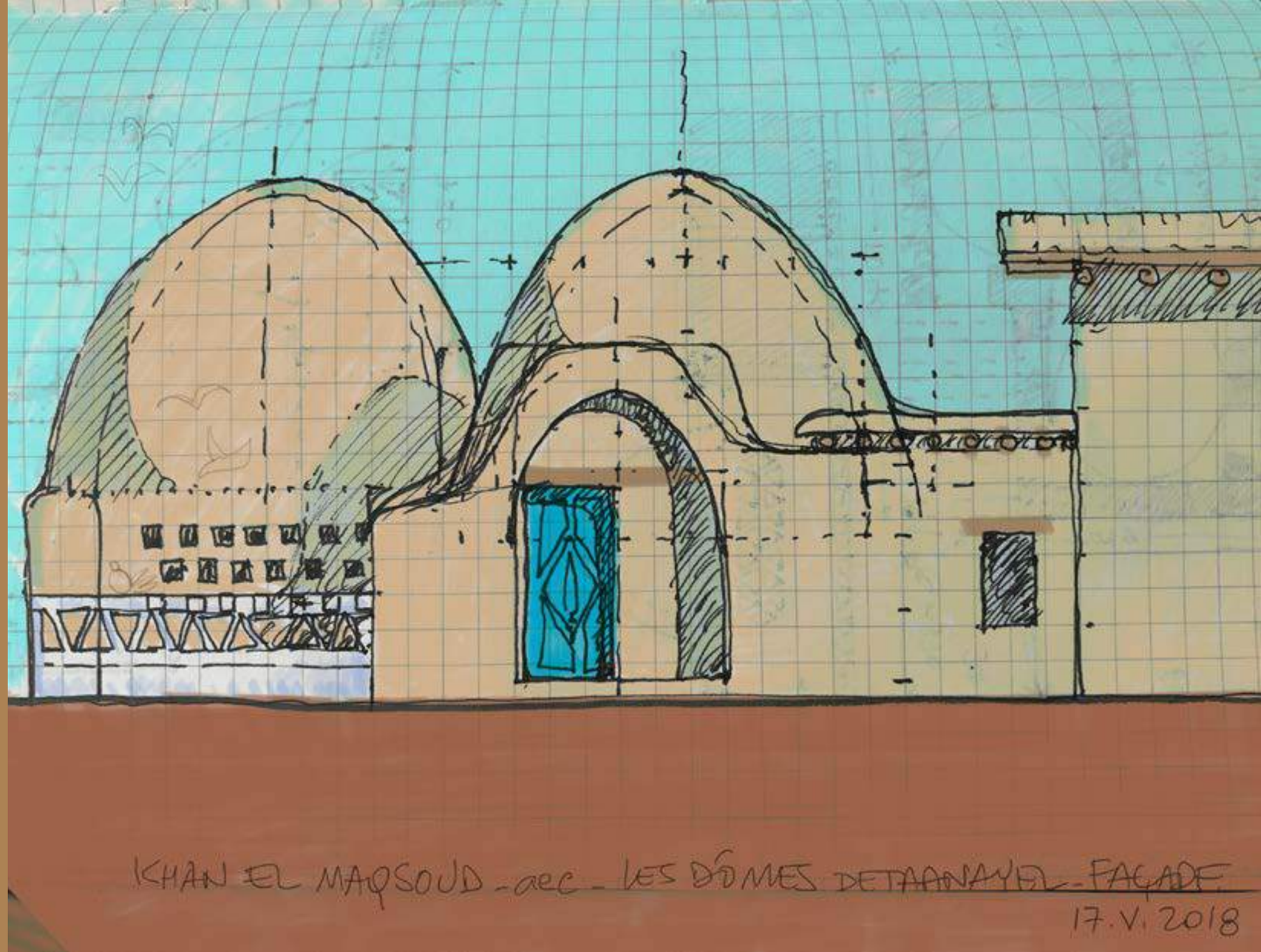




Annexe 2

Establishment of plans

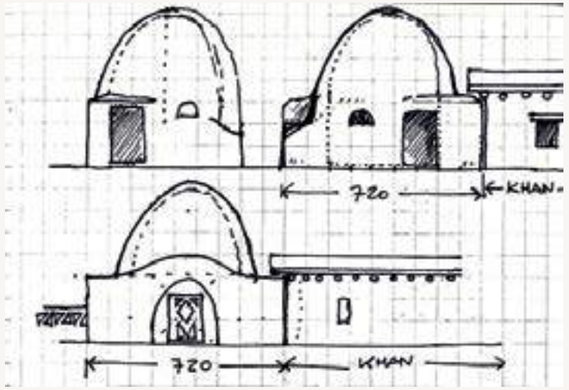
Fadlallah Dagher

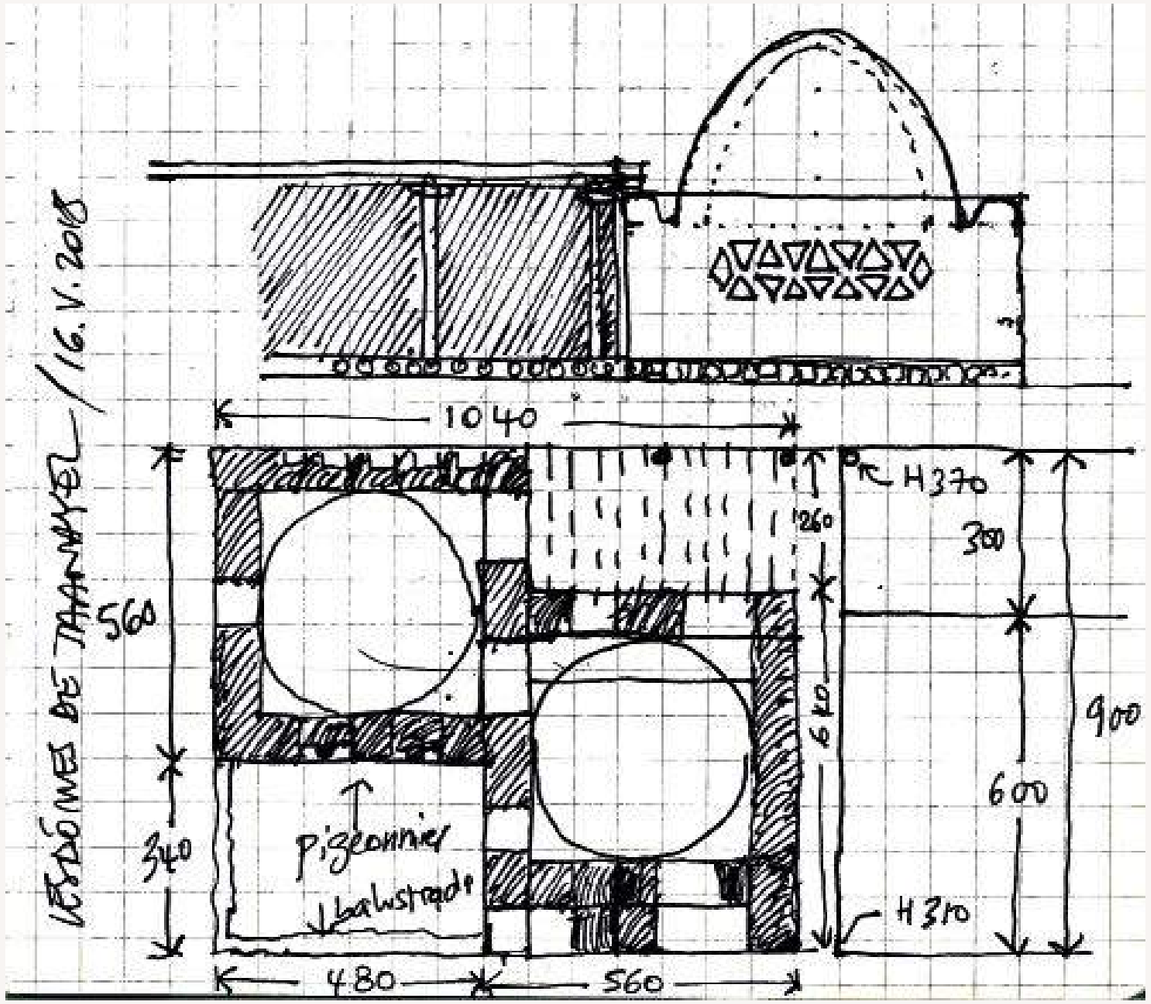


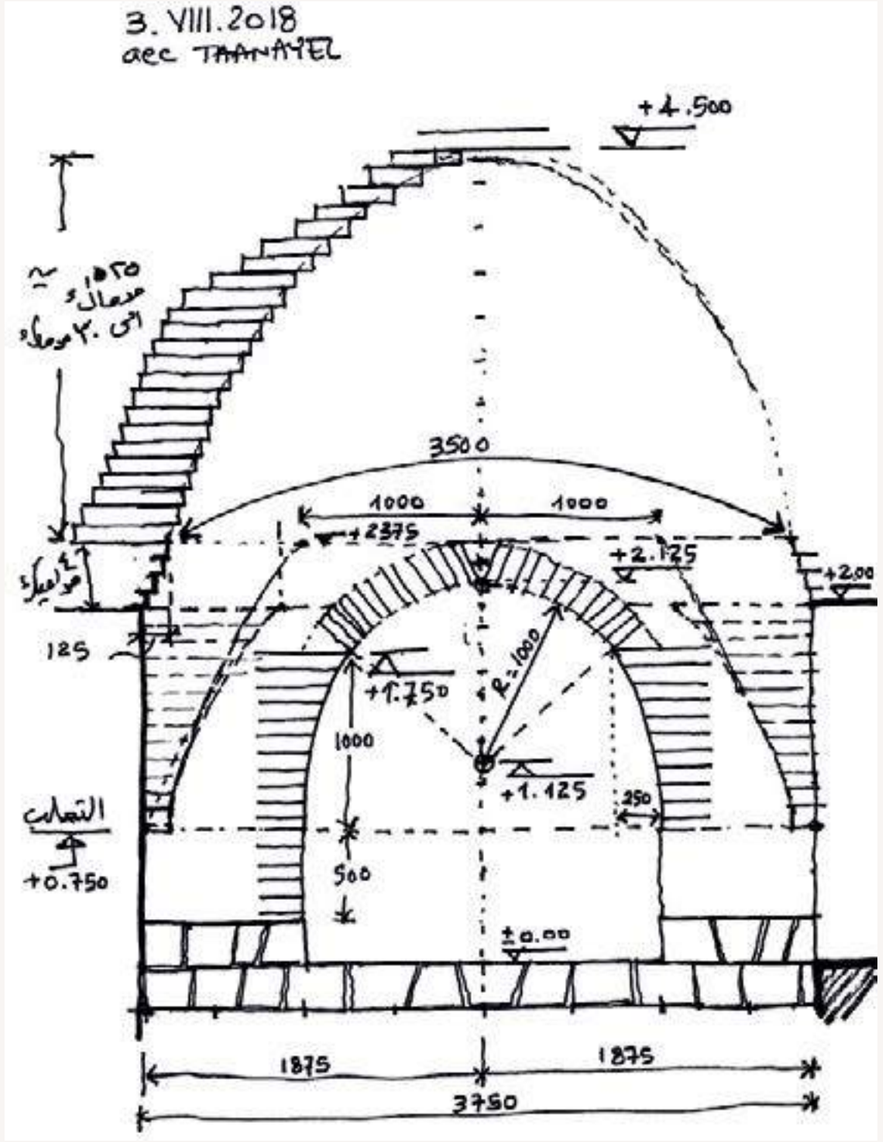
Establishing plans for the recreation of missing or inaccessible vernacular buildings, namely the domed houses of northern Syria, seemed to be a haphazard and scientifically refutable undertaking in the absence of reliable records. However, we had to draw the elements of these constructions to confirm the layout, organize the work team, set the deadlines of the construction, calculate the quantities of materials needed and establish the overall budget of the operation.

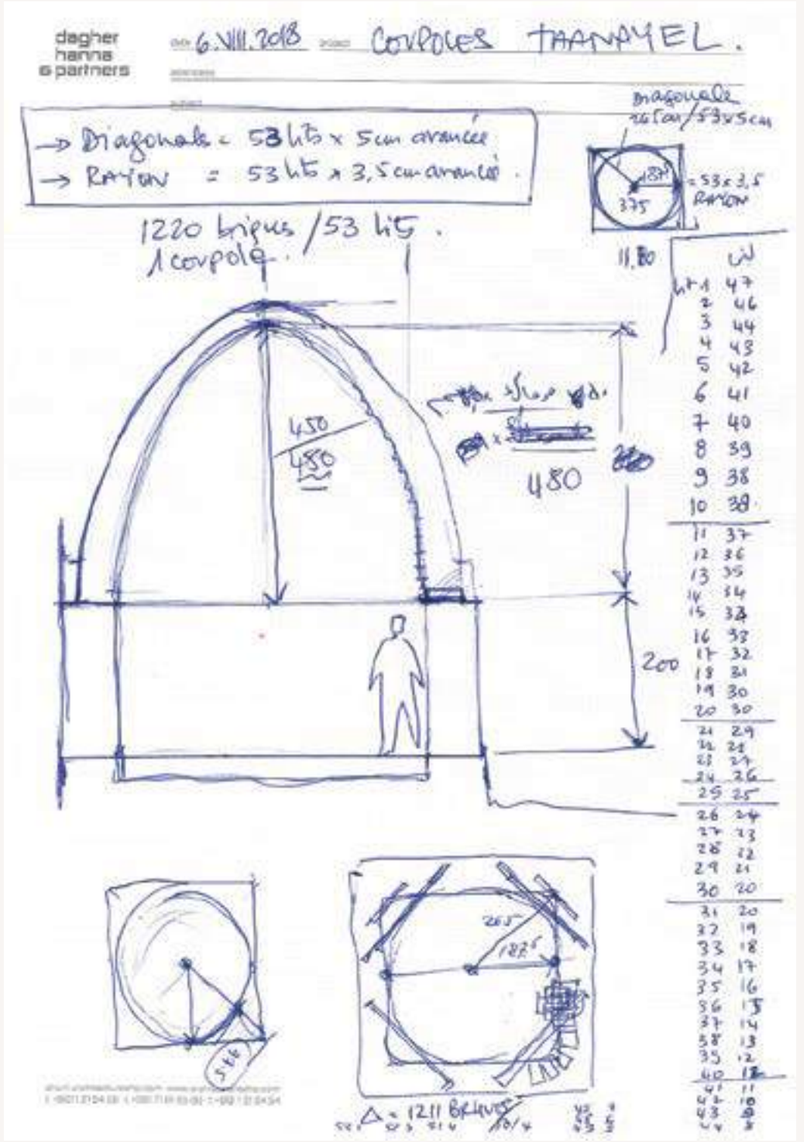
The main source of documentation was the abundant photographs of Houda Kassatly and Karin Puett's De Terre et de Lumière (Al-Ayn editions, 2011). However, we did not have any architectural records with noted and indicated dimensions. Assuming that the space of a domed chamber would be a square of 4 m square and helped by our experience of traditional adobe brick construction and our memories on the ground during visits to Syria in the 2000s, we were able to build a first project in plan, section and perspective for the construction of two adjacent rooms.

This draft was then confronted with the observations and comments of the Syrian Masons with whom it was discussed. Thus the size of each room was reduced to 3.75 m side. They told us that the dome would start by cutting each corner with a piece of wood placed diagonally, the thaclab, then it would rise in successive corbels of an empirical value of two fingers forward for each bed of bricks. The height of each element of the construction was agreed according to the human sizes and the usual rules, and we could thus calculate the quantity of adobe bricks that we had to manufacture as well as the quantities of stones for the base and the pieces of wood thaclab. The plan of the two rooms in a row and their position on the site at the entrance of Khan el Maksoud were frozen. Finally, the project was completed by adding a gallery, rwâq, on its north face, to ensure continuity with the existing Khan. These various observations were drawn in sketches on the site and broadcast on the spot to all major stakeholders.
During the construction, we regularly visited the site to check the conformity of the execution with the established scheme and with the models photographed by Houda Kassatly and to ensure the stability of the works. It was only at the end of the construction site that we were able to draw a cut with precise dimensions. Thus, engaged in an empirical way, this joint venture in which the architect was a scribe listening to the masons makes it possible to have today in drawing of the fundamental rules to erect a house with cupolas in adobe bricks.









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38	13
39	12
40	12
41	11
42	10
43	9
44	8

Annexe 3

Particle size analysis

Red earth	**%**	***Huwwâra***	**%**
Gravel	5	Gravel	10
Sand	40	Sand	15
Silt	15	Silt	15
Clay	40	Clay	60
Plasticity	**7.3**	**Plasticity**	**17.4**

Particle size:
gravel (≥ 2mm), sand (2 to 0.02mm), silt (0.02 to 0.002mm), clay (0.0002mm).

This analysis was carried out in the laboratories of the American University of Beirut at the request of Angèle Keserwany.

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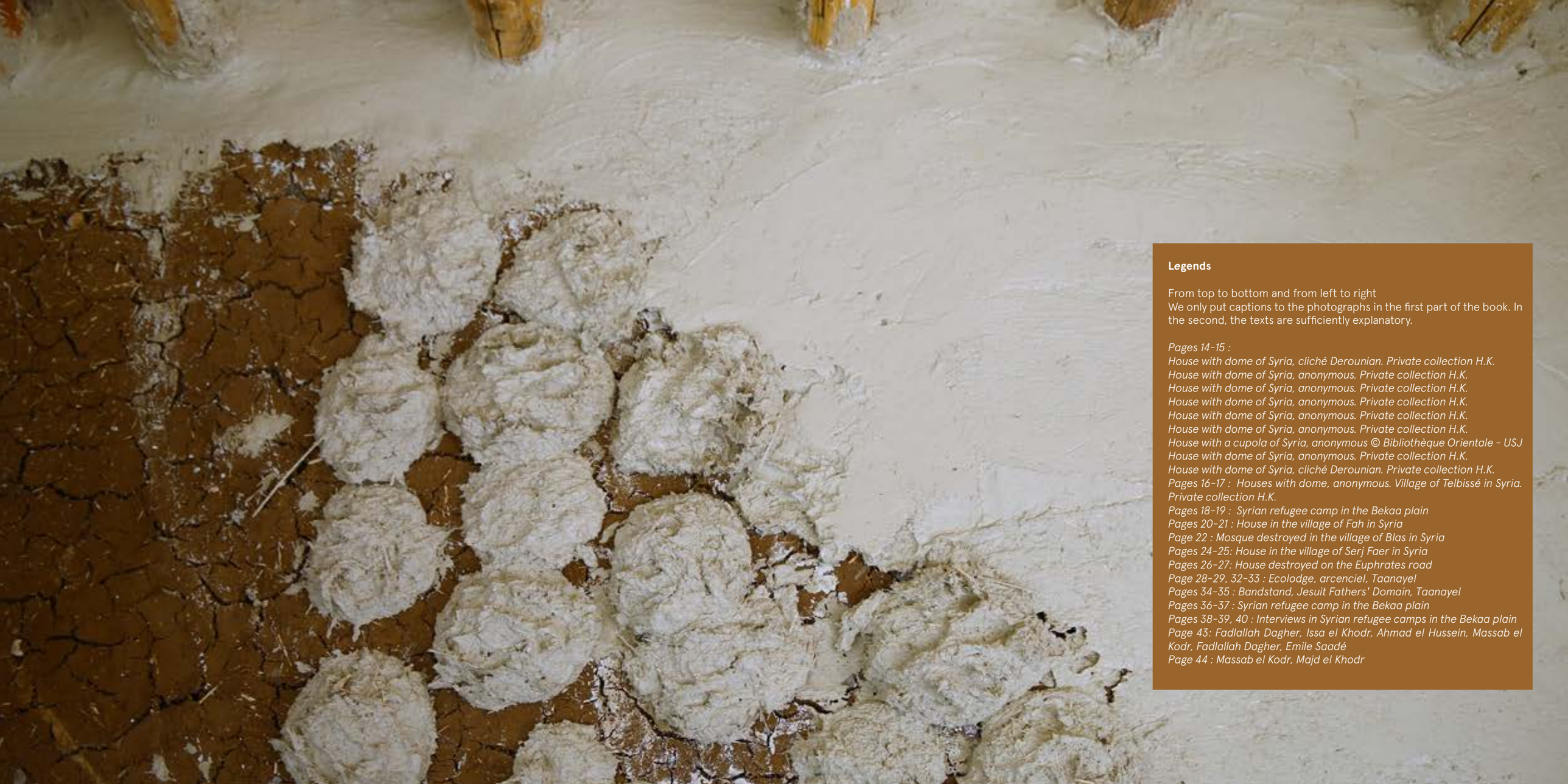

Legends

From top to bottom and from left to right
We only put captions to the photographs in the first part of the book. In the second, the texts are sufficiently explanatory.

Pages 14-15 :
House with dome of Syria, cliché Derounian. Private collection H.K.
House with dome of Syria, anonymous. Private collection H.K.
House with dome of Syria, anonymous. Private collection H.K.
House with dome of Syria, anonymous. Private collection H.K.
House with dome of Syria, anonymous. Private collection H.K.
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House with dome of Syria, cliché Derounian. Private collection H.K.
Pages 16-17 : Houses with dome, anonymous. Village of Telbissé in Syria. Private collection H.K.
Pages 18-19 : Syrian refugee camp in the Bekaa plain
Pages 20-21 : House in the village of Fah in Syria
Page 22 : Mosque destroyed in the village of Blas in Syria
Pages 24-25: House in the village of Serj Faer in Syria
Pages 26-27: House destroyed on the Euphrates road
Page 28-29, 32-33 : Ecolodge, arcenciel, Taanayel
Pages 34-35 : Bandstand, Jesuit Fathers' Domain, Taanayel
Pages 36-37 : Syrian refugee camp in the Bekaa plain
Pages 38-39, 40 : Interviews in Syrian refugee camps in the Bekaa plain
Page 43: Fadlallah Dagher, Issa el Khodr, Ahmad el Hussein, Massab el Kodr, Fadlallah Dagher, Emile Saadé
Page 44 : Massab el Kodr, Majd el Khodr

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All the photographs of the book are by Houda Kassatly except the photographs of the introduction of Fadlalah Dagher and the photography pages 74-75 of Elia Ghorra.

Drawings and sketches

Youmna Berbery : pages 110-111, 124
Fadlallah Dagher : pages 103-104, 210-211, 234 à 239
Robert Reyfouni : pages 68, 70, 72, 90, 112-113, 120-121, 132-133, 154, 196