Recovery of

THE MAUSOLEUM OF SUNQUR SA'DI

and restoration of

MEVLEVI TAKIYYA

Recovery and restoration works carried out in 2002–2007

by the Centro Formazione Professionale Restauro (C.F.P.R., Italy) www.cfpr.it

in the *work-site school* of the Italian Egyptian Centre for Restoration and Archaeology (CIERA)

in cooperation with

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Giuseppe Fanfoni

PRESENTATION

Many were the Italian travellers, emigrants and exiles who went or settled in Egypt and dedicated themselves to discovering the vestiges of this country's past. It was a passionate search which brought to the finding and valorisation of incredible masterpieces.

Then, as time went on, the interest continued to grow incredibly and a more mature approach gradually developed, devoted to the intrinsic meaning and historical value of the remains of the past, regardless of what condition they were found in or of their beauty. Even if the objects were found in a not good or fragmentary state, they were not discarded or utilized as materials for so-called restorations which were no more than "pastiches". Once the romantic phase had passed, during which the ruins were left in the condition they were found in or even moved and used as ornamentation in gardens or squares, wth regard to the monuments anastylosis and restoration work was carried out in order to avoid looting and further deterioration.

Dating from the Renainaissance period, Italy developed a strong interest towards the study and the retrieval of ancient monuments and had already acquired a tradution of restoration. Italy was thus a pioneer in developing that sensitivity of interest and respect towards antiquity, which nowadays characterizes the approach of conservation and preservation of objects and ancient monuments.

It is no coincidence that the first famous restorer of monuments in the world was an Italin from Egypt: Alessandro Barsanti, born in 1858 in Alexandria, whose parents emigrated from Tuscany. He graduated in engineering and architecture in Italy, and then returned to Egypt. He became the right-hand man of the then director of the Service of Antiquities, Gaston Maspero, a Frenchman whose parents came from Lombardy. This was during a particularly difficult moment and Egypt owes a great debt to this modest man of great genius who has been forgotten by history. It is thanks to him that some of the most important and magnificent monuments have been preserved. Many were the Italians that operated in restoration and contributed to create a culture for conservation in Egypt, not last among them arch. Achille Patricolo, director of the *Comité de conservation des monuments de l'art arabe*, who led restoration works from 1915 to 1919 in the mausoleum of Sunqur Sa'di. Italian restorers kept on operating on the protection of Egyptian great archaeological and monumental heritage, mainly in the field of conservation of Nubian monuments in Aswan, in the sixties and seventies and more recently with the important intervention of the restoration group led by Paolo and Laura Mora of the Italian Central Institute for Restoration, for the complete recovery of Nefertari's tomb in the valley of Queens and with the restoration of the Monasteries of Saint Anthony and Saint Paul.

This same spirit of collaboration and closeness between our cultures again characterizes Italy's offer of the most advanced techniques in the field of restoration and link it to the Egyptian experience of artisanship and restoration, by creating a new type of school where theory and practice operate in synergy, and carry out the restoration of a vast area of monuments forming, at the same time, a large group of restorers at various levels, thanks to the activities of the work-site.

The project of the "work-site school", which has been operating for many years, has now restored the majority of the most important historical buildings of the area where the Italian-Egyptian Center for Restoration and Archaeology is located and carries out its work. At the same time, the project has contributed to the formation of hundreds of trainees who work there: from specialized artisans to graduate restorers, many of whom have reached a very high level within the university organizations and those of the Supreme Council of Antiquities or are associated in the activities of the Center where they hold managerial roles.

I would like to conclude by underlining the importance of the continuity of this initiative which has obtained very significant results, enhancing the links of cooperation between Italy and Egypt. I hope that the Center will become a permanent school with its own autonomy in order to allow for the development of the specialization of knowledge and intervention techniques, particularly in the field of monumental restoration, with special regard to the various historical periods.

Claudio Pacifico
Ambassador of Italy
In Egypt

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1 THE MONUMENTAL AREA

1.1 Buildings and archaeological remains

The Italian-Egyptian Centre for Restoration and Archaeology[1] (CIERA) operates in one of the largest monumental complexes in historical Cairo.

The area is about 7.500 m^2 wide, it offers an extraordinary range of different architectural periods and styles and includes historical and artistic remains dating from the Arab conquest of Egypt to present.

The following is a list of the most notable buildings (fig. 2):

- The Palace of Qusun-Yashbak-Aqbardi: built and expanded with additions from the 14th to the 16th century; this is the largest part of the monumental complex.
- Madrasa of Sunqur Sa'di (14th century) and the underlying archaeological area, with remains of settlements from different periods, starting from the 7th century AD, the date of the Arab presence in Egypt.
- Mausoleum of Hasan Sadaqa (14th century), the minaret of which is characterized by an unusual *hilal* (a dervish hat instead of the more common crescent).
- The *takiyya,* or "convent," of the Mevlevi dervishes; its construction started in the 16th century in the area between the remains of the madrasa of Sunqur Sa'di and the Yashbak Palace, adapting to the new function whatever could be utilized from the old monuments.
- *Sama'khana* or Hall of hearing (referred to cosmic harmony): a theatre-like structure built by Mevlevi dervishes (beginning in the 19th century) to perform the *sama',* the ceremony of circular movements that is typical of their mystical confraternity. Its plan is based on deep symbolic meanings, and it is one of the last existing examples of this rare architectural typology.

1.2 Qusun-Yashbak-Aqbardi Palace (14th–16th centuries)

The Amir Qusun, confidant of the Sultan Muhammad Ibn Qala'un, was bound to him by family ties, having married one of the Sultan's daughters; furthermore, his sister was Ibn Qala'un's wife. He was held important appointments and was one of the most powerful amirs of the 14th century, rival of the Amir Bashtak because of his relationship with the Sultan.

His magnificent palace presents architectural features similar to those of the Bashtak palace and is one of the most impressive Mamluk buildings in Cairo, even if it is reduced to ruins today.

Built between the years 1330 and 1337 AD to the east of the Sunqur Sa'di *madrasa*, it was subsequently enlarged and completed by Yashbak in 1476, after whose death it became the property of Aqbardi.[2]

Archaeological surveys put in evidence that the buildings adjoined by Aqbardi were erected on the area previously occupied by Sunqur Sa'di *madrasa*, at that time (15th-16th century) in an evident state of ruin.
The whole area of the palace, together with the remaining of Sunqur Sa'di other monumental buildings, finally passed to the Mewlewi Dervishes.

1.3 Building activities of Sunqur Sa'di (14th century)

Sunqur Sa'di lived during the reign of Sultan al-Nasir Muhammad Ibn Qala'un, in a period of particular wellbeing and wealth for Egypt during which, as the famous historiographer al-Maqrizi (d. 845 H/1442 AD) noted, many people, in a period full of conflicts for power, lived in unrestrained luxury and indulged in permitted as well as sinful pleasures, while others dedicated themselves to Sufism, the arts and the sciences. Therefore, construction activity increased with the building of schools and mosques to such a degree that a registration office for architectural works had to be created.

Al-Maqrizi[3] describes Amir Shams al-Din Sunqur Sa'di, *nakib*[4] (representative) of the Mamluk Sultans, as a pious and very rich man engaged in social work as well as in the development of agricultural and construction activities. The documents attest and prove that Sunqur Sa'di constructed many monumental buildings and even founded a village, al-Nahariyya, with a mosque and a mill, which rapidly prospered.[5] This village still exists in al-Gharbiyya region, halfway between Cairo and Alexandria

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[1] The "Italian-Egyptian Centre for Restoration and Archaeology" was sanctioned by an executive protocol between the Italian and the Egyptian Government on the 2nd of February 1988. It was officially inaugurated on the 28th of July 1988, on the occasion of the opening to the public of the restored Mevlevi Sama'khana, after a long activity of training and restoration, in cooperation with the Supreme Council of Antiquities (S.C.A.). The Centre was born thanks to the activity of a group of Italian experts (teachers, technicians and artisans), who created an Association in 1986 (C.F.P.R.) coordinated by the present Director of the Centre, Prof. Giuseppe Fanfoni, who has been engaged since 1978 in the challenging mission of recovering the objects and the monuments in the area. Since the very beginning all activities had an educational purpose. This is, indeed, a "work site school," where the practical activity of restoration is linked to the scientific and technological research and to the training (both theoretical and practical) of the different professional figures working in the restoration process: workmen, technicians, artisans, professionals.

[2] Cf. J.Revault, B. Maury, *Palais et maisons du Caire (II)*. Le Caire, 1977, pp. 31–48; tavv. XXIII–XXXVI. Archaeological research has revealed the fact that the buildings of Aqbardi were erected on the area previously occupied by the Sunqur Sa'di *madrasa* and laid on these structures, evidently already ruined at that time (XV-XVI centuries). The entire area of the palace passed together with the Sunqur Sa'di complex to the Mevlevi dervish confraternity.

[3] Cf. Al Maqrizi, *Khitat*, vol. II, 1853–4, p. 397.

[4] For the historical significant and office of the *nakib* cf. G. Canova, *Le iscrizioni nel Complesso dei Dervisci Mevlevi del Cairo: il Mausoleo di Sunqur al-Sa'di (Qubba di Hasan Sadaqa)*, "QSA" 1 nuova serie, 2006, p. 192, note 5.

[5] Cf. G. Wiet, *Liste des villes d'Égypte citées dans Khitat Maqrizi*, Le Caire, 1913, s.v. El Nahharieh.

1.31 The monumental complex of Shari' al-Suyufiyya

Sunqur Sa'di constructed these buildings, which he considered the most important of his life, in the zone that al-Maqrizi called *Hadrat al-Bakar*, outside al-Qahira town walls, on the road "al-Azam" (11th century), the principal axis connecting the city to the Ibn Tulun Mosque in the countryside (al-Fustat). In the part of the *madrasa*, this axis took the name Shari' al-Suyufiyya[6] (fig. 4). The architectural complex consisted of a *madrasa*, or Quranic school, a *ribat*, a kind of hospice or welfare centre for orphan girls, widows and elderly women,[7] and finally the mausoleum where he wished to be buried. However**,** the wish of Sunqur Sa'di to be buried in the mausoleum that he had built for himself could not be fulfilled because of serious conflicts that arose with Qusun, the owner of the majestic palace neighbouring the complex built by Sunqur Sa'di. Because Qusun was also an important personality tied to Sultan Ibn Qala'un, Sunqur Sa'di was forced to go to Tripoli, where he died in 728 H/1328 AD[8]

His magnificent mausoleum was utilized some years later by Shaykh Nasr al-Din Sadaqa and by his nephew, Hasan Sadaqa, from whom the mausoleum takes its name (fig. 3). Shaykh Nasr al-Din Sadaqa, son of 'Abdallah al-Arrani, was head of the corresponding chamber of commerce in the 8th century H/14th century AD. 'Ali al-Sakhawi traces the death of Nasr al-Din Sadaqa to 745 H/1344 AD.[9]

Later on the whole complex of Sunqur Sa'di *madrasa* gradually ruined. In fact the same building activities of the Mewlewi Dervishes (starting from the 16th century) set their foundations on the ruined structures of Sunqur Sa'di *madrasa*.

The *madrasa* must have been greatly admired and aroused rivalry and envy, probably because of the richness of the decorations still visible in the annexed mausoleum, which are an indication of its ancient splendour. Not very far from this complex, on the shores of the big pool Birkat al-Fil, Sunqur Sa'di also built a mosque which, as al-Maqrizi reports, was destroyed by Prince al-Tawashi ad-Din Bashir al-Gandar al-Nasiri in order to build in its place a *madrasa* that must have been more beautiful than the one built by Sunqur Sa'di. This was constructed in the year 761 H/1360 AD and a library was annexed to it. Unfortunately this *madrasa,* one of the most elegant of its time, was also destroyed and today only one *iwan* of the building remains.[10]

1.4 The buildings of the Mevlevi dervishes

1.4.1 The Mevlevi dervishes

The Order of the Mevlevi dervishes, commonly called "whirling", was established during the 13th century in Konya, Turkey. Its founder, Jalal al-Din al-Rumi to whose teachings the Mevlevis refer, was born in Khurasan (Afghanistan) on 30th September 1207.

At the age of five he was compelled to leave, following his father, the great mystic Baha' ad-Din Walad called "the Sultan of the Scholars." After some pilgrimage, he settled in Konya where he died in 1273 and where he was buried. Konya, the "Mother House" of the Order has since then been the destination of pilgrims from all over the world.

Compared with St Francis of Assisi for his sensitivity and Jacopone da Todi for his culture and his powerful eloquence, he is considered "the greatest mystic poet of all time."[11] His collection of poetry, *Divan-i Kibir*, together with his mystic poem, *Masnavi-yi Ma'navi* constitute the cultural base of the order which owes its origins to him.

The Mevlevi Order underwent a slow but constant expansion until the advent of the Ottoman Empire. During that period many personalities of great importance in the world of culture and politics, interested in the philosophical and musical culture of the Mevlevi and in the thought of Jalal al-Din al-Rumi, were adherents of the Order.

In 1491 AD, 86 Mevlevi *takiyyas* existed[12] and during the following centuries the Order grew. Along with the Ottoman expansion it spread through the Islamic world with many centres connected with the Mother House in Konya. To this period their settlement in Cairo refers.

1.4.2 The Mevlevi takiyya (16th –20th centuries)

The buildings forming the Mevlevi *takiyya* developed in the area between the remains of Sunqur Sa'di *madrasa* and the palace of Qusun-Yashbak-Aqbardi.

The Mevlevi received this area as a donation (*waqf*) from the Yemeni Amir Yusuf Sinan Pasha in 1016 H/1607 AD.[13] From the donation document it is evident that the Mevlevi were already living in the *takiyya*, at that time named Sa'diyya, next to the area that was later received as a donation. It refers to their first settlement, which occurred in 1596 under the control of Ni'meti

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[6] For the location of the sites indicated by *Maqrizi*, cf. M.G. Salmon, *Études sur la topographie du Caire. La Kal'at al Kabch et la Birkat al Fijl,* Le Caire, 1902, pp. 58–9; 113–4. Further elements of the location of the ensemble are provided by 'Ali Pasha Mubarak, *op. cit.,* p. 7.

[7] Al Maqrizi, *op. cit.*, p. 397.

[8] Cf. Al Maqrizi, *op. cit.,* p. 397. That date is confirmed by Ibn Hajar al-Asqalani, *Al-Durar al-Kamina* (vol. II), p. 273. The 727 H is instead the date of death according to Ibn Iyas, *Bada'i' al-zuhur* (I), Bulaq, 1311 H/1893 AD, p. 164.

[9] El-Hasan Nur al-Din 'Ali al-Sakhawi, *Tuhfa el Habajeb wa Baqiyat el Tallab fi el Khitat wa el Mazarat*, Cairo, 1973, p. 109.

[10] Cf. Al Maqrizi, *op. cit.,* p. 399; 'Ali Pasha Mubarak, *Al khitat al-Tawfīqiyya al-Jadida* (IV), Bulaq, 1305-6 H/1888-9 AD, p. 4; *Comité de conservation des Monuments de l'Art Arabe*, Es. 1915–19, vol. XXXII, Cairo, 1922, p. 106.

[11] Cf. A. Bausani*, Rumi, Poesie mistiche*, Milano, 1980, pp. 5, 35.

[12] Cf. H. Ritter, *Neue Litteratur ũber Maulana Galaluddin Rumi and seinen Order, in "Oriens"*, XIII–XIV (1961), p. 348.

[13] Regarding the donation documents, cf. G. Canova, "Iscrizioni e documenti relativi alla takiyya dei dervisci mevlevi del Cairo", in *QSA* 17 (1999), pp. 123–141; with regard to organizational aspects, cf. also G. Fanfoni, *The foundation and organization of the Cairo Mevleviyya.* "QSA" 17 (1999), pp. 105–122.

Dede. This settlement, according to the description from Prof. Mahmud Kiliç,[14] occurred after some restoration work on the existing buildings and with the addition of the essential elements for the organization of the *takiyya*.

In light of the fact that the donation made by Sinan Pasha had at its western boundary the existing *takiyya*, named Sa'diyya, we can presume that this first settlement (see fig. 5) occupied the area of the Sunqur Sa'di madrasa together with the cells at the sides of the central court (at present under the *sama'khana*) and the area of the mausoleum (B), the west *iwan* (C) and the minaret, which are still visible today. The great *iwan* (C) was probably used for the performance of the *sama'*, because it is located near the mausoleum, while the other (eventual) rooms of the *takiyya* developed to the south.[15]

As they were already well organized, the Mevlevi must have used the area donated by Sinan Pasha without making many changes to it for a certain period. In fact, some ceramics, from the time of the dervishes, found on the level of the rooms of the *madrasa,* indicate that they were used by the Mevlevi before the construction of the *sama'khana*.

The restorations and integrations, which gave the Mevlevi architectural complex its final appearance, were carried out between the 18th and 19th centuries, also thanks to further donations.[16]

Some building activity on the Aqbardi structures is from1234 H/1818 AD and is indicated as a note in the document of the donation by Sinan Pasha.[17] Some interventions were carried out thanks to the support of the authorities; 'Ali Mubarak reports some construction and restoration work promoted by Sa'id Pasha, that is, in 1854–1863.[18] In fact, inside the *sama'khana*, in the central medallion of the dome, we can see the date 1274 H/1857 AD, and on the paintings above the pillars, that of 1282 H/1865 AD.

According to an inscription on a slab found during the work and now displayed in the museum section, some work in the kitchens and in the access to the gallery of the convent was carried out in 1334 H/1915–16 AD;[19] this work was confirmed by the archaeological findings in areas E0 and F1–F2 (fig. 67), as described in section 6.1.3.

Then, during the restoration work in the building along Shari' al-Suyufiyya, we found traces of the addition of several rooms, which we left visible as evidence of the enlargements (fig. 69, 71). However, the major building activities were carried out during the middle of the 19th century.

The Mevlevis were inspired by the plan and the architectural characteristics of the Mother House in Konya and by some other complexes typical of the Order. By partially utilizing the pre-existing structures of the Sunqur Sa'di *madrasa* and the Aqbardi palace, the architectural unit was divided into different areas according to their function (fig. 9): (3,4) the worship area with the *sama'khana* and the mausoleum; (6,9) the monastic life area made up of cells surrounding a garden with a fountain in the centre, as in Konya; (7,8) the common daily activities area with rooms for meetings, for prayers, the refectory and the kitchens; (10) the public area with reception areas which delimited it from the outside world and was also the entrance to the *takiyya* and to the big Aqbardi garden. Here, pilgrims who came to rest and poor people who came to ask for food were received. In the centre of this architectural complex, one of the few still complete in all its various sectors, the *sama'khana*, the central element of the worship area is placed[20].

1.4.3 The sama'khana

The Cairo *sama'khana* was one of the latest to be built during the long period of the existence of the Mevlevi confraternity (fig. 10, 11).

According to historian 'Abd al-Rahman Fahmi, the construction of the *sama'khana* we can see today can be dated to 1225 H/ 1809 AD;[21] therefore the dates in the central medallion of the dome and in its drum (1857 and 1865 AD, respectively) refer to the paintings only and indicate that the *sama'khana* had been constructed gradually.

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[14] Here I would like to thank Prof. Mahmud Erol Kiliç for providing me with the following note about the arrival and settlement of the Mevlevi in Egypt: "It is known, from Mevlevian sources, that the first Mevleviyya was established in the Zawiya of shaykh Sadaqa and the first shaykh was Ahmed Safi Dede. But we know from Gholshani sources from Ubudi's Menaqib (living in 1604) that at the beginning the Mevlevi in Egypt were hosted in the *takiyya* Gholshani where Ibrahim Gholshani gave them some rooms and the Mevlevi joined the Gholshani dervishes for their *sama'*. When their number increased and they formed their own group, they needed their own space. Therefore the Qadi of Egypt, Ahmed Ansari (died 1600), in agreement with Ali Sawfet (died 1597), shaykh of the Gholshani at the time, decided to give the Mevlevi the Zawiyat Halaviyye, which was empty. They repaired it and settled there (around 1589–90); their first shaykh was Ni'meti Dede. Their group increased in number and therefore they needed a bigger place in Cairo. The Zawiya of shaykh Sadaqa, a Badawi shaykh, was empty and almost in ruins. Defterdar Sinan Beg renewed it by adding the *sama'khana,* the sacred hall (*meydan'i sherif*) and the kitchen to the main buildings, so that it became Mevleviyya in style. Then the Mevlevi moved here and started performing their dance. This *takiyya* was officially opened after a big banquet in 1596, under the control of Ni'meti Dede."

[15] Cf. G. Fanfoni, *The foundation, op. cit.*, p. 108.

[16] In particular: a second donation numbered 2816, in 26 pages, by Prince Hassan Ibn Hussein Aga, dated 20 rabi'tani 1137 H/1724 AD; the donation by Ismail Pasha, dated 1208 H/1793 AD, numbered 865.

[17] Cf. G. Fanfoni, *The foundation…, op. cit.*, p.108.

[18] Cf. 'Ali Pasha Mubarak, *op. cit.*, p.45.

[19] Cf. G. Canova, *Le iscrizioni nel complesso…, op. cit.*, p. 204.

[20] Cf. G. Fanfoni, Historical and architectiral aspects of the Cairo Mawlawiyya, in Proceedings of the 11th International Congress of Turkish Art, Utrecht-The Netherlands August 23-28, 1999, in "Electronic Journal of Oriental Studies" Volume IV (2001), M. Kiel, N. Landman & H. Theunissen (eds), internet Address: htt://www.let.uu.nl/EJOS>.

[21] Abd Al Rahman Fahmi, *Bayn adab al-maqama wa fann al-'imara bi-l-Madrasa al-Sa'diyya (Qubbat Hasan Sadaqa)*. In *Majllat al-Majma' al-'Ilmiyy al Misriyy* (vol. 52), Cairo, 1970–71, p. 44 note 2.

As in other rare examples of this last period, the area dedicated to the dance is circular and the whole complex has a central plan.

In the development of this peculiar architectural typology, from the first centralized plan in Manisa (14th century)[22] to that of Kutaya (19th century), both in Turkey, the *sama'khana* in Cairo, contemporary to the one in Kutaya, represents the final stage of its evolution.[23] It represents the maximum expression of the geometric and cosmological symbolism defining the functions and proportions of the architectural space in which the *sama'*, the mystic dance of the Mevlevi, takes place[24] (fig. 11).

The Cairo *sama'khana* was also the last to remain active after the edict, which closed the *takiyya* and the dissolution of the dervishes' Turkish confraternities, was issued by Ataturk in 1925.

The board with the inscription "*Ya hadrat Mawlana*" placed over the post where the shaykh of the Order sat during the rite of the dance, was signed by Shaykh 'Abd al-'Aziz Rifa'i and dated 1341 H/1922 AD. This board confirms a moment of particular vitality for the confraternity of Shari' al-Suyufiyya; in fact, Muhammad 'Abd al-'Aziz Rifa'i, who is considered prince of the calligraphers, copied and decorated a Quran for King Fu'ad.

On 13th June 1928, the well-known Lebanese writer, May Ziyada, wrote a long article in *Al-Ahram* newspaper, describing the *sama'*, which she attended in the *takiyya*. In 1932, the Mevlevi group participated in the "Congress of Arab Music" held in Cairo with eight musical pieces.

Around 1945 the Cairo Mevlevi group was also dissolved and the *sama'khana*, together with the Hasan Sadaqa Mausoleum and the tombs, which had previously been taken care of by the Mevlevis, were abandoned.

In addition, the *Comité de Conservation des Monuments de l'Art Arabe*[25], which had supported the preservation works of the Mevlevi area, was dissolved and its function was transferred to the Egyptian Antiquities Organization (E.A.O) in 1953. The E.A.O., thanks to the interest of Prof. 'Abd al-Tawab, gave instructions to construct a wall closing off the main entrance to the *sama'khana*, avoiding in this way some eventual damage, surely greater than that caused by lack of maintenance.

Interest in the *sama'khana* was sparked in 1975 by Prof. Carla M. Burri, who was the director of the Italian Cultural Institute at the time and promoted both the structure's restoration and the *work-site school*, which was organized by the author.[26]

2. Restoration accomplished before 2002

The first restoration intervention carried out in the area involved the *sama'khana* as the central element of the architectural complex. It was also in a worse state of preservation than the other buildings and some parts of its dome had already collapsed.

Since 1978, the various operative sections of the restoration have supported practical training courses offered to students in the Department of Restoration at Cairo University, so the organization of the project had the characteristics of a *work-site school* from the very beginning.

In 1988 we completed the recovery of the *sama'khana*, which has turned out to be the most significant example in the world of this specific architectural typology.

In 2002 we recovered the *madrasa* of Sunqur Sa'di, whose plan is a peculiar example of Mamluk Bahri architecture. The restoration involved archaeological excavations under the *sama'khana*, which was built using part of the structures of the madrasa[27] (fig. 7, 8).

3. Restoration carried out in 2002–2007

3.1 Buildings involved in the interventions

In 2007 the restoration of the following was completed (fig. 14):

- *Mausoleum of Sunqur Sa'di* (known as that of Hasan Sadaqa; B in the plan in (fig. 5), in which we recovered the marble tomb;
- The cells of the Mevlevi convent (E in the plan), along the front of the *sama'khana*;
- The reception rooms (G-H in the plan) in the wing of the convent on Shari' al-Suyufiyya.

We also carried out the architectural survey of the monumental building Qusun-Yashbak-Aqbardi and began preliminary studies on how to bring about its recovery.

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[22] Cf. G. Goodwin, *A history of Ottoman architecture*, London 1971, fig. 36.

[23] Cf. G. Fanfoni, *Historic evolution of the sama'khana architectural typology*. In *International Congress on Mawlana Jalauddin Rumi* Istanbul-Konya 2007. For the text see www.CFPR.it).

[24] Cf. G. Fanfoni, *An underlying geometrical design of the Mevlevi sama'khana in Cairo*, in "Annales Islamologiques" 24 (1988), p.229, Planche XI.

[25] As for the commitment and activities carried out by the Comité cfr. in Attachment, Notes on the History of the restoration, par. 1.3

[26] Cf. G. Fanfoni, *Il complesso architettonico dei dervisci Mewlewi in Cairo*. In "RSO" LVII, (1983), p. 77.

[27] For the *sama'khana* a detailed technical publication has already been done (cf. G. Fanfoni, *The restoration of the Mwlawi Sama'khana in Cairo*, Cairo, 2006); for the madrasas, a preliminary outline was published for the inauguration of the restoration completed in 2002 (cf. G. Fanfoni, The Madrasa of Sunqur Sa'di and the Mevlevi Museum, Cairo, 2002). Therefore, this publication describes technical work carried out mainly from 2002 to 2007, with completion of technical references, when appropriate, for the actions taken in previous years.

3.2 Degradation of the buildings before restoration

The main causes of the degradation of the buildings restored in 2002–2007 were:

- settling foundations in the reception rooms of the convent facing the street (G–H) and in the mausoleum (B);
- rising damp, which caused damage in all the buildings, most visibly in the mausoleum and especially in the stucco inscriptions;
- lack of maintenance, which augmented the effect of the aforementioned problems.[28]

The corridor (A) beside the *mausoleum* was completely flooded, and the level of water varied constantly between 5cm and 30cm. Water occasionally leaked into the hollow space separating the mausoleum from the street, because of damage to the water mains. The floor of the mausoleum (B) was entirely soaked. The action of salts was visible up to a height of 6m on the interior and up to 8m on the external walls of the mausoleum (fig.15). Vertical cracks inside the mausoleum, with a maximum expansion toward the floor, reached the height of 7–8m on the northern, southern and western walls (fig. 35).

The buildings along the street (G-H) presented visible traces of settling foundations along their entire surface; the vaulted shop spaces were also damaged, thus increasing the detachment and shifting toward the street of the whole façade. In fact, the upper floor presented an ongoing shifting toward the street, relative to the whole sector, of approximately 5m corresponding to the depth of the shops; the cracks, with their maximum expansion upwards, presented traces of repairs dating to different periods (figg. 70, 71).

None of the rooms, both in the shops and on the upper floor, were hygienic enough for habitation as a consequence of structural damage and the dampness of the walls.

The buildings of the cells of the convent around the courtyard in front of the *sama'khana* did not have any static problems of foundation settlement. Nonetheless, the rooms on the ground floor were not in a habitable condition due to the degradation caused by humidity, which was rising from the ground and from the walls by capillary action, and the presence of salts. The upper floor displayed sinking on the balcony and in the rooms, with damage caused by infiltration of rain. The general degradation was mainly due to a lack of proper maintenance (fig. 15 E-F).

3.3 Guiding principles of the restoration

During the restoration work, especially in the mausoleum and in the *madrasa* of Sunqur Sa'di, alterations, adaptations and many previous interventions appeared at various points.

We followed the general principle that we should focus on the recovery of the architectural identity of the buildings. However, we respected the most significant previous changes that had occurred because they are part of the history of the buildings.

Structural interventions were determined by the need for a static stabilization of the building and the need to conform to the safety parameters nowadays established for public buildings; the technical solutions we adopted were characterized by *minimal intervention*.

We designed elements with *supporting functions*, so that the formal and technical character of extant structures was not altered; such supporting elements interact with the structure but do not mix with it and are therefore *clearly distinguishable*.

Tie rods were used inside the walls to bind the structures and allow the different parts to react in the same way to eventual sinking or settling. In particular, in the G-H building a steel framework inside the walls forms a cage that binds all of the structures together (fig. 71).

Injections (fig. 16) were made in the cracks to fill the empty spaces caused by the settling of the walls. Other generic injections or injections in a mesh pattern were avoided because they would alter the wall structure, which would also cause non-homogeneous reactions to earthquakes or other structural settling.

Ancient wall structures present many internal empty spaces, both in *a sacco* walls,[29] where this is unavoidable, and in normal masonry of stone or brick courses.

This is typical of Egyptian building tradition. Already in the Pharaonic period, the setting of raw bricks was carried out only with horizontal mortar. This left the inner vertical spaces empty, which made it easier for the bricks to dry (fig. 17).

In ancient wall structures, internal empty spaces interrupt the capillary action, thereby reducing rising damp and at the same time allowing the deposition of salts. In a compact wall, these deposits cause the wall to expand, thus causing serious damage. We therefore tried, where possible, to respect and preserve the balance of the original structure.

Rebuilding with the *cuci-scuci* technique[30] was limited to wall parts lacking cohesion and, where possible, we used a particular texture of masonry that differentiated it from ancient walls in order to make these parts clearly *distinguishable*.

Even on the external stone faces of the façade of the mausoleum, we avoided the traumatic replacement of the ashlars, although these were seriously deteriorated (see section 5.17.3 below). The parts corroded by salts and humidity were reintegrated with stucco in such a way as to be clearly distinguishable thanks to the use of a different material in the integration and the fact that it is lower than the original (fig. 60 C-D).

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[28] The earthquake in 1992 increased the ongoing settling and the cracks but did not cause any new phenomena.

[29] The *a sacco* wall is characterized by careful construction of the two sides of the wall and the gradual filling of the spaces between them with mortar and stones of different sizes.

[30] A technique that consists of demolishing (*scuci*) and rebuilding (*cuci*) subsequently sections of the wall.

Every intervention was made to be clearly *distinguishable* from the original with regard to both the external appearance of the monument and the internal structural interventions. In the integration of the wooden ceilings of the convent, when necessary, added or replaced beams were made visible by the addition of a red stripe (fig. 63 D–E).

When possible, *reversible materials* were used; painting integrations were usually done using watercolours; a final surface protection was added using Paraloid B72 (figg. 88, 92, 93).

All the mortars used in the walls or in consolidating injections were produced using the same basic components as ancient mortars, thus ensuring their *compatibility*[31] and an appropriate interaction with the original structural elements.

Detailed documentation of the state of preservation of the structural elements and of the materials used preceded our work. *Essential scientific analyses* were carried out on more than a hundred samples of mortars, stuccoes and other materials in order to identify the materials and their state of preservation in relation to the intervention. For this reason, the Centre established a laboratory specializing in the studies and analyses necessary for our work on the site,[32] both during the work and for didactical demonstration.[33]

Every stage of the restoration has been amply documented. We also produced *detailed documentation* after completing of the work, in order to compare it with the state of conservation before restoration, and to integrate the information provided by the description of the operations and the visibility *in situ* of the interventions.

These interventions were carried out in accordance with the following concepts:

- *the visibility* of the intervention;
- *the compatibility* of the materials used with the original ones;
- *the reversibility* of both materials and intervention, where possible.

Special attention was paid to the preservation of the form and technique of the monument using:

- *Minimal intervention* in order to preserve the shape;
- *Supporting structures*, in the case of structural interventions, in order to preserve original techniques and technologies;
- *Detailed documentation* before, during and after the intervention, especially in the case of changes.

4. THE MADRASA OF SUNQUR SA'DI

The elements belonging to the architectural complex of Sunqur Sa'di run along Shari' al-Suyufiyya for 23.2m, and their ground level is 1.80m lower than that of the street.[34]

An open, hollow space where it is possible to walk, with eight steps leading down to the entrance, was built by the *Comité* from 1915 to 1919 as a protective area between the street and the building.[35]

On the left of the mausoleum is the minaret, whose total height is 32.35m. The minaret can be divided into two levels: the lower has a square plan and is decorated by a niche motif; the upper level, the *mabkhara*, which rests on an octagonal floor that was once surrounded by a balustrade, is richly decorated with keel-arched niches and with the upper structure of *muqarnas* headed by a cylindrical ribbed element topped by a *hilal* in the shape of a Dervish hat instead of the more common crescent.

The elegant entrance portal opens onto a corridor that was part of the original plan of the *madrasa* and at present has no roof (A in the plan, fig. 5). From the layers of plaster and the traces that remain of the original ceiling we can infer that this corridor was covered at a height of 6m from the ground to create housing spaces not belonging to the Sunqur Sa'di complex. In a cavity (at a height of 6.5m) we found a wisp of hair and fragments of cloth. The wall mortar and the finishing plaster on this northern side of the mausoleum are made of lime only,[36] whereas the other walls are made of lime and plaster at this height.

On the right side of the corridor, a small door leads into the mausoleum (B), which has a square plan covered by a dome and was built by Sunqur Sa'di as an essential part of the *madrasa*.

From the mausoleum, another small door opens onto the only extant *iwan* (C) of the *madrasa* of Sunqur Sa'di. The *iwan* has an irregular rectangular plan, measuring approximately 6 by 11m and 8.9m in height.

Our work and the study of the wall structure confirmed that the *iwan* was originally vaulted and that the false wooden ceiling bearing inscriptions on its perimeter had been built by the Mevlevi dervishes who settled there in the 16th century, when the abandoned *madrasa* was already a ruin.[37]

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[31] Our *work-site school*, during its twenty years of activity, could test the compatibility of the mortars used in the restoration with the original materials.

[32] Regarding the analyses, it might be useful to quote Torraca's considerations regarding their correct purposes: "[…] If in fact the scientific technical analysis becomes almost mandatory, they are also a rich market [...] thanks to the demand for expensive tests and of little use [...] The results of a scientific study are determined in a decisive manner by the proper setting [...] and by the intellectual honesty who interprets the results, when these do not this is just a show to impress the superintendents and the Media […]" cf. G. Torraca, "Il progetto di restauro tra artigianato e industria lo studio scientifico e la documentazione", in *Le scienze, gli operatori, le istituzioni alla soglia degli anni 90*, Padua 1988, p. 208.

[33] The criteria and procedures adopted in the analysis of the materials are in accordance with the indicated standards (ASTM, NORMAL, RILEM, etc.), especially with regard to studies carried out in specialized laboratories on the site. In the analyses carried out in our laboratory, the surveys and the study of materials on site, the production of mortar and plaster samples, procedures and applications were adapted to the needs of the site and to immediate and more effective didactics, while also considering the progress of the work.

[34] This street, dating back to the 11th century, gradually reached its present level by accumulation of materials; the Sābil wa rab'al-Qazlar of 1028 H/1618 AD, in front of our architectural complex, indicates the level of the street in the 17th century.

[35] Cf. *Comité de conservation des Monuments de l'Art Arabe*, Es. 1915–19, vol. XXXII, Cairo, 1922, pp. 81, 553.

[36] For mortars, see section 7: Observations regarding mortars and their use

[37] Cf. G. Fanfoni*, La Madrasa di Sunqur Sa'di…,, op. cit.*.

This wide room was, in the original plan of the *madrasa*, the west *iwan*, which was separated by a huge pointed arch still extant (figg. 19, 117) from the central courtyard, the *sahn* of the ancient madrasa.

Beyond this arch, 3.3m above the ground level of the *iwan*, is the *sama'khana* of the Mevlevi dervishes (D in the plan in fig. 5). The presence of this recent building impeded our attempts to conduct surveys and gather elements useful to the understanding of the plan of the *madrasa*.[38] The identification of underlying structures therefore became one of the purposes of the restoration.

The excavations that we carried out under the *sama'khana* were very useful for the didactic aspect of the *work-site school* since they required specific techniques and methodologies: the carrying out of an elaborate engineering and artisanal project complemented a methodical archaeological survey that allowed us to bring to light the framework of the *madrasa* of Sunqur Sa'di.

The interventions of restoration and conservation conducted in the architectural complex of Sunqur Sa'di and the study of the extant structures and decorations, together with the necessary archaeological surveys, made it possible to reconstruct the vicissitudes of the monument.

The results of archaeological surveys and restorations were presented on 15 May 2002. These resulted in the recovery of the remains of the *madrasa* of Sunqur Sa'di.

The *madrasa* turned out to be a peculiar example of Bahri Mamluk architecture with two *iwans* facing each other on the short sides of the courtyard, although historians had supposed it had four *iwans*.[39] Here we found the late Ayyubid motifs attested also in the *madrasa* of al-Salih Najm al-Din (1243 AD), the first with four *iwans* and comprised of two identical buildings placed side by side, each with two *iwans*, and linked by a minaret, which unifies the monumental complex. This minaret is stylistically similar to that of Sunqur Sa'di and is placed at the front of the building as an essential element of the entrance, thereby separating the two parts and creating a good interaction between architecture and city planning. Compared to the *madrasa* of al-Salih Najm al-Din, that of Sunqur Sa'di is identical to one of its parts and is also similar, in many respects, to the plan and decorations of the oldest Ayyubid *madrasa*, erroneously called the mausoleum of Mustafa Pasha (1267 AD) (fig.20).

The plan of the *madrasa* of Sunqur Sa'di was characterized by a central open courtyard measuring 11.7 by 12.6m with a central area paved with bricks; rooms were on the long sides of the courtyard and on the short sides were two *iwans*, one to the west and the other to the east in the *qibla* position (fig. 8, 20).

Half of the courtyard area, which measures 7.50 by 7.50m, had been deprived of the bricks (probably removed and reused for different purposes) and a *fiskiya* (fountain) was revealed, of which only the water basin remains. Meanwhile, the parapet was cut to ground level to reveal the brick floor. The fountain might have belonged to an older building, as this was an area of urban expansion at the time of Ahmed Ibn Tulun.

When we built the plinths for the new supporting foundations of the *sama'khana,* it was necessary to remove the southeast angle of the perimeter of the fountain, and at a level 60cm lower we found a well that had been covered to build the fountain over it. Beside the well we found the fragments of a large jar that was probably used to store water taken from the well when this area was used for breeding animals in the period of the Arab al-Fustat town (7th century). Archaeological excavations could not go further due to leaking water on this level. The jar was recomposed, restored and displayed on the site where it was found. We also reconstructed the perimeter of the fountain with a steel band, as a visual documentation for visitors (fig. 21).

Along the long sides of the courtyard were four rooms measuring approximately 2.80 by 2.30 by 3.70m; the dimensions of the rooms are those of the southern side of the courtyard of the *madrasa*, the perimeter wall of which remained intact in its height, approximately 11m, the equivalent of three floors. It was possible to rebuild the rooms on the ground floor of this side.

We found only the outline and the base of some of the stone revetment of the rooms on the north of the *madrasa*, so we reconstructed just the outline of the doors to indicate their location. The northern side as it was drawn integrated with the southern side, complete with its stone revetment, in order to reconstruct an integral view of the central courtyard of the *madrasa* (fig. 22 A-B). The internal divisions of the northern rooms were marked with a simple chromatic differentiation on the floor. We thus obtained a wide room that we used to display pictures and documents regarding the Mevlevi and to house some showcases containing archaeological findings from the excavated area.

5. The Mausoleum of Sunqur Sa'di

The exterior of the mausoleum is characterized by a well-proportioned sequence of spaces and volumes separated by refined stucco frames and crowned by a section of Quranic inscriptions, one of the peculiarities of this monument.[40]

The internal space of the mausoleum has an irregular plan (length of the sides: 8.42 x 7.93 x 8.41 x 7.73m) and reaches, at the top of the dome, a height of 18.80m. The internal space is characterized by two bands of stucco inscriptions: the first is a visual reference at the height of 3m, and the second, at the height of approximately 7.30m, marks the transition to the intermediate level of *muqarnas*, which goes up to the springer of the dome (fig. 3).

In the central area of the mausoleum were four wooden sarcophagi covered by drapery according to the tradition of Mevlevi dervishes.[41] The largest of the four, bearing inscriptions and decoration, is placed beside the *mihrab* and relates to Hasan Sadaqa.

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[38]Cf. K. A. C. Creswell, *The Muslim Architecture of Egypt* (II). Oxford 1959; pp. 267–269; see also the Comitée report: Patricolo, vol. XXXII, *op. cit.*, p. 81 "Il serait intéressant, dans le but de s'assurer s'il existe encore des vestiges de parties disparues, d'exécuter des travaux de sondage. Mais ceux-ci presentent de nombreuses difficultés, dont la plus grave consiste dans la presence de la takia des derviches, dite d'al-Maoulawiyah, bâtie à l'est des parties anciennes, à l'endroit même où probablement s'élevait la madrasah."

[39] Cf. Doris Behrens-Abouseif, *Islamic Architecture in Cairo: An Introduction*. Cairo, 1989, p. 108.

[40] For the internal and external inscriptions in the mausoleum, cf. G. Canova, *Le iscrizioni nel complesso dei dervisci Mevlevi…*, *op. cit.*, pp. 191–216.

The sarcophagus at the centre of the mausoleum (the third from the *mihrab*) contained the remains of the marble tomb of Sunqur Sa'di, which was uncovered during archaeological and restoration work. The other two sarcophagi can be connected with Mevlevi burials (fig. 25 B).

A peculiar element of this monument is the date, which is written in numbers instead of letters[42] at the end of the lower band of inscriptions above the door that leads to corridor A (fig. 25 A). The date (721 H/1321 AD) is probably the date of completion of the inscription and of the mausoleum itself. We know from Maqrizi that the mausoleum was built in 715 H/1315 AD and that Sunqur Sa'di, because of his dispute with Amir Qusun, was obliged to leave Egypt and died in Tripoli in 728 H/ 1328 AD.[43]

Differences in the dates have caused many arguments among historians. However, from the point of view of the architecture, it seems certain that Sunqur Sa'di, after his expulsion from Egypt in 723 H/1323 AD, was not able to control his mausoleum, where his marble cenotaph remained unused. Despite this, the fact that Shaykh Nasr al-Din Sadaqa (died 745 H/1344 AD) and (probably much later) his nephew Hasan Sadaqa were buried in the sarcophagus, the inscription on which recalls the fact that the mausoleum had belonged to Sunqur Sa'di, means that they were careful and respectful of the mausoleum near the *mihrab* in which they were buried (fig. 26).

The inscription on the large wooden sarcophagus says that the mausoleum was built by Amir Sunqur Sa'di and bears the date *rabi I* of year 715 (5th June 1315), but pointing out that the sarcophagus belonged to Shaykh Sadaqa.[44] The date is presumably the date of the construction of the mausoleum, which was finished in 721 as the inscription indicates, because shaykh Sadaqa, a prominent personality in Cairo, died in 745 h. / 1344 AD. His nephew Hasan Sadaqa was then buried with him also. The records of the *Comité* state that the mausoleum derives its name from Hasan Sadaqa, shaykh of Amir Nasir Sunqur Sa'di, who was buried in the sarcophagus beside that of his master near the prayer niche.[45]

After this period the complex was gradually abandoned, and it is certain that it was already in ruins by the end of the 15th century, as the west section of Aqbardi palace, built around 1485–1495, was superposedly over the *madrasa* of Sunqur Sa'di (fig.8).

It was in this area of ruins that Mevlevi dervishes settled at the end of the 16th century after adapting the extant parts of the *madrasa* to the needs of their order. From then on, the mausoleum received maintenance and care, although these were limited by the economic means of the Mevlevi.

Then, in 1892, the *Comité*, based on the report of its technical board of 25th August (no. 136), decided to include the "*Coupole et Minaret du Tékiet el Maoulaouieh*"[46] on the list of the monuments to be preserved. These were the dome of the mausoleum of Hasan Sadaqa and the nearby minaret, the only elements of the *madrasa* of Sunqur Sa'di (14th century AD) that were intact at the time. They are listed in the *Index to the Muhammedan Monuments in Cairo* (Cairo 1951) with the number 263.

From that time, the *Comité* granted, when necessary or possible, their support and advice to the Mevlevi who were already engaged in the conservation of the monumental remains of the *madrasa* and continued to be so until the confraternity abandoned the area in 1945. In 1953 the management of Egyptian Islamic monuments was then transferred from the *Comité* to the *Egyptian Antiquities Organization*.

5.1 The *Comité*'s work from 1915 to 1919

The work carried out by the *Comité de Conservation des Monuments de l'Art Arabe* is remarkable. From 1892, when the mausoleum and the madrasa were listed among the monuments to be preserved, until 1953, the *Comité* constantly worked on the maintenance of the monument by carrying out some important interventions.[47]

The methodology and restoration techniques used by the *Comité* conform to the most qualified international culture of conservation and restoration that had developed by the middle of the 18th century,[48] and whose basic concepts are still valid today.

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[41] Regarding fabric typologies and their colouring, cf. E. F. Panaitescu and G. Scala, "Tessuti, fibre e tintura dei Dervisci Mevlevi del Cairo (Egitto)", in *Informatore Botanico Italiano*, (3X) XXX-XXX, 2008.

[42] Already noted as the first example of Mamluk decoration in architecture by K. A. C. Creswell, *op. cit.,* (II), p. 268.

[43] Cf. Al Maqrizi, *op. cit.*, p. 397.

[44] Cf. the Appendix "The inscriptions in Sunqur Sa'di mausoleum". In detail, G. Canova, *Le iscrizioni nel Complesso dei Dervisci*..., *op. cit.*, pp. 199–202.

[45] Cf. A. Patricolo, *Comité*, *op. cit.*, p. 81. "...Le tombeau prend le nom de Hassan Sadaqa, chaikh de l'emir an-Nacir Sounqour Sa'di, qui y est enterré, et dont le sarcophage est situé à coté de celui de son maitre, près de la niche de prière."

[46] Cf. Comité ….., exercice 1892, op. cit. pp. 75–81.

[47] Cf. A. Patricolo, in *Comité de conservation des Monuments de l'Art Arabe*, *exercices 1915–19,* vol. XXXII, Le Caire, 1922; pp.80–82, tavv. LXXX-LXXXIII, and in particular: *exercice 1892*, vol. IX, Le Caire, 1903, pp. 75–81; *exercice 1894*, vol. XI, Le Caire, 1908, p. 55; *exercice 1899*, vol. XVI, Le Caire, 1901, p. 114; *exercice 1900*, vol. XVII, Le Caire, 1902, pp. 11, 31, 103; *exercice 1901*, vol. XVIII, Le Caire, 1904, p. 32; *exercice 1908*, vol. XXV, Le Caire, 1909, p. 82; *exercice 1909*, vol. XXVI, Le Caire, 1910, p. 125; *exercice 1910*, vol. XXVII, Le Caire, 1911, p. 90; *exercices 1915-19*, vol. XXXII, Le Caire, 1922, pp. 543, 553, 695, 764; *exercices 1925–26*, vol. XXXIV, Le Caire, 1933, pp. 17, 69; *exercices 1930-32*, vol. XXXVI, Le Caire, 1936, p. 270; *exercices 1933–35*, vol. XXXVII, Le Caire, 1940, pp. 103–105. In the 1980s, Medhat al-Minabawi, the then director of the South Cairo Inspectorate, gave me a report on the documentation of the work carried out in the mausoleum (n. 263) that is preserved in the Islamic and Coptic Antiquities Department. According to this report, other work was carried out besides that of the *Comité*. In particular, in July 1945 some interventions on the entrance door of the mausoleum were commissioned from the builder Saad Allah Nusir, and in 1954 other restorations were commissioned from the builder al-Hagg Muhammad Hassan Ahmad, who consolidated some inscriptions, plastered the whole wall up to the first band of inscriptions and above the first band of inscriptions where the plaster had fallen off.

The *Comité*'s most significant interventions on the mausoleum were carried out in the period from 1915 to 1919. They were encouraged and followed by the director of the *Comité* at that time, Italian architect Achille Patricolo.[49]

From the very beginning, the main problem pointed out by the technical committee of the *Comité* was the damage caused by humidity to the façade and in the interior of the mausoleum. To cope with the gravity of the problem they created an air space all along the façade.[50] The two large windows of the mausoleum and of the *iwan*, which had previously been buried, were thus brought to light, improving both the façade and the interior of the building.[51]

The works completed at that time probably saved the monument from an impending catastrophe: the walls were rebuilt to the height of approximately 3m in the interior and 4.3m in the external corridor, all of which reinforced the monument which was being plagued by rising damp (fig. 35). The restoration of the walls carried out in the corridor and within the interior can be recognized by the size of the stone ashlars (45–50 x 18–22 x 12–14cm) that were usually employed by the *Comité*. From the results of the analysis, we can say that the mortars used by the *Comité* were made of selected lime and sand (fig. 91, skeleton 5).

However, the amazing results achieved by the *Comité* did not solve the problem because they did not address its origin. Rising damp, the main cause of the damage to the mausoleum, was allowed to continue to threaten the structure with devastating effects, especially for the stuccoes and internal decorations. Many parts of the stucco decorations fell down over the years, and all the materials that could be, were saved in the depository waiting to be restored.

5.2 Rising damp

Among the activities for the recovery of the monuments in the area, one of the hardest problems to cope with was the removal of humidity, which is dangerous for buildings and harms the people who live in them.

As we know, in modern buildings this problem is solved during the construction phase, as it is a rule to interpose a waterproof physical barrier between the foundation structure and the wall. The absence of humidity is a hygienic necessity required by the laws governing modern living spaces. It is therefore necessary, whenever possible, to adapt ancient buildings to current law.[52]

Damage caused by rising damp is a frequent and well known problem of Egyptian monuments due to the presence of salts in every building material as well as in the ground upon which foundations are laid.

The importance of this phenomenon in the process of deterioration caused by the cyclic crystallization of salts was scientifically explained in an article already published in 1902 and then again in 1915 by the well-known physicist A. Lucas.[53]

Water absorbed by the ground dissolves salts and brings them to the surface until they reach the evaporation level, which varies according to the thickness and characteristics of the wall structures, and the wall's interaction with the environment. As an effect of the evaporation of water, salts crystallize causing the pulverization of the material that absorbed them. This process occurs as a result of variations in humidity that alternately dissolve and crystallize salts, and if it is not blocked with the proper intervention, it leads to the accumulation of salts in the internal cavities of wall structures, which causes them to break and eventually collapse.

In particular, the crystallization of salts creates different phenomena according to the characteristics and porosity of the materials, the resistance of capillary canals, the pressure of the liquid conveying the salts and interaction with other environmental factors. In the areas of the interventions we noted the presence of (fig. 82):

A *concretions* with an accumulation of up to 4cm in porous materials; these can bring the salts to the surface without visible damage to the structure of the stone;

B *efflorescences* with whitish surfaces;

C *subefflorescence* with *pelliculation* caused by the occlusion of pores on the surface that probably resulted from an erroneous application of consolidating products on the surface which impeded the outflow of salts, or

D *subefflorescence* with detachment of flakes;

E *cryptoefflorescences* with *erosion* and *pulverizing* on the surface due to efflorescences produced inside the capillary veins, which are not very resistant to the pressure of the outflow of salts;

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[48] See Attachment, *Notes on the History of the restoration*, and, for further information about the history of restoration, A. Conti, *Storia del restauro e della conservazione delle opere d'arte*, Milan, 1988.

[49] Patricolo. *Comitè de conservation*. Es. 1915–19, vol. XXXII. Cairo 1922; pp. 80–82; ill. LXXX- LXXXIII. Cf. in particular p. 81: "… Maqrizi, qui donne la description de l'èdifice tel qu'il etait de son vivant, et qui comprenaint aussi une *madrasa* et un hospice de femmes. Ce qui en reste est le minaret, la salle du tombeau et une salle contigue du coté sud.

[50] Patricolo, *op. cit.*, p. 81 "La façade ouest, sur la rue as-Seyoufieh, comprend le beau portail et les fenêtres éclairant le mausolée et la salle contiguë. Elle était exposée aux effets pernicieux de l'humidité, étant surélevé par rapport à celui de l'intérieur de l'édifice. Après accord avec le Service du Tanzim, une étroite bande de terrain adhérente à cette façade a été déblayée jusqu'au niveau des fondations. Ce dégagement a eu pour résultat l'assainissement des murs et a permis en même temps de rétablir la pleine vue des fenêtres qui étaient à moitié obstruées par les terres."

[51] Patricolo, *op. cit.*, p. 553 "La section technique constate avec plaisir que le dégagement de la façade ouest a désormais assuré l'assainissement partial de l'intérieur du tombeau, fortement éprouvé par les infiltrations de l'humidité."

[52] Cf. G. and I. Massari, *Damp Buildings old and new*, ICCROM, Rome, 1993, p. 51-52: "Most major cities nowadays have health regulations on humidity in houses. Such regulations vary greatly from one place to another, depending on the climate, typical construction materials and living habits of the community. …, the following maximum warer percentage by weith that walls may safely contain from a health viewpoint is: 3% for common brick walls..., 6% for walls of tuff, sandstone or other,..."

[53] A. Lucas, *Disintegration and Preservation of Building Stones in Egypt*. Cairo: Government Press, 1915. "For such crystallization to take place three conditions are necessary: first the presence of water-soluble salts, secondly the presence of water to dissolve the salts, and thirdly opportunity for salts to be brought to the surface of stone and there to crystallize out by the evaporation of the water holding them in solution."

F *concretions of needle-shaped* salts between the wall support and the plaster, with the expulsion and deformation of the decorative layer;

H–I *concretions* with *fractures* inside the stone and the wall structures in the veining and the gaps in the materials.

Analysis (XRD) indicated, essentially, the presence of sodium chlorate (fig. 82, graphic G).

In any case, humidity is the essential factor in the creation of these phenomena. Salts transported by water travel upward with a *capillary movement* to a height of 3m in ordinary walls and can reach over 6m in thicker walls (3m or more). Or, in areas already invaded by salts and displaying a significant accumulation of them, they spread in a *molecular way* from the area of highest concentration in all directions, always activated by the presence of humidity.[54]

In the *sama'khana*, the problem of rising damp was solved through the integrated action of two interventions (fig. 28):

- the injection of special epoxy resins into holes running through the whole wall, which reduces the section of the wall that draws the rising damp upward;
- the creation of one air space under the external ground level with an opening to the north and another on a higher level to the south that allow the constant ventilation of the walls and thus decrease the residual rising damp.[55]

5.3 Moisture in the mausoleum

Leaking water, up to a few centimetres above the floor, has been attested in the mausoleum since the 1980s, while the whole of corridor A, whose level was 50cm lower, was permanently flooded.

Both inside and outside the mausoleum rising damp caused visible damage to stone facings, plaster, stucco decorations and even wall structures (fig. 27).

We measured moisture for two years inside and outside the mausoleum, and the result was that wall structures were soaked internally up to 4–5m according to the thickness of the walls (ranging from 1 to 3m) and to the kind of masonry (which was entirely of brick in the *mihrab*).[56]

The internal floor of the mausoleum was constantly soaked and the superficial measurement (taken with an electrical meter) on the four walls of the mausoleum indicated an average moisture content of around 80% with a maximum of over 95% in some areas, even over 4m high, and up to a height of 6–7m. This is due to the spread of moisture on the surface, which is caused by the *molecular diffusion of salts* (as described above) and their interaction with relative humidity (RH) in the interior of the mausoleum, generally measured as being over 80% (measurements were carried out with a psychrometer at the height of 1.50m from the ground).

Condensation humidity on walls normally appears with an RH close to saturation, but in the presence of salts absorbing air humidity it appears at even lower RH values, as it is related to the deliquescence of salts, which, in the case of sodium chlorate, occurs at around 76% RH.

At the beginning, the monument was affected by all of the aforementioned phenomena. Thus, rising damp with floor and wall moisture, condensation humidity and the action of salts combined to create a general degradation of the whole building without allowing the possibility of clearly distinguishing the separate effects of each of the three phenomena.

5.4 The technique of physically barring humidity

In 1988 we decided to conduct an operation to bar rising damp in the structures of the *madrasa* and the mausoleum by cutting the walls at the base and inserting a damp-proof course in the entire wall thickness. Unfortunately, due to lack of funds, it was not possible to start the project until four years later.

The system of using a barrier at the base of the wall was traditionally performed in Venice, a city that has had to cope with the problem of moisture from its origins. It consisted in demolishing sections of the wall one after the other *(cuci-scuci)* using hand tools, and then inserting a lead sheet.

This cutting technique, called *a breccia*, can be carried out on walls about 1m thick, operating on both sides. It consists of demolishing a section of wall of 50–70cm wide, according to its consistency, and up to 30–40cm high, according to necessity. After this the damp-proof layer is inserted (lead sheet, polyester sheet or bitumen, 2–3mm.); finally the wall is reconstructed leaving out an edge of the damp-proof layer (about 5cm) which will overlap on the damp-proof layer of the following section. The operation is then continued on another section of 50–70cm, in succession.

The *a breccia* cut technique was improved using an electric core drill to cut and giving the operation a precision and mechanical character, according to the Massari method. Using a truck corer, the ground level is cut in sections of 42cm and then filled with epoxy resin or polyester. The work proceeds with cuts of 3.5cm diameter along the whole thickness of the wall in a horizontal line and at an interval of 2cm one from the other; after this first series of holes another series is carried out, in the intermediate

[54] We demonstrated this phenomenon in the course of theoretical lessons: filling 1/3 of a coffee cup with water saturated with sodium chloride, in two or three days salts rise to form crystallizations that extend up over the brim of the cup and even down its outside. This phenomenon of spreading via molecular diffusion only ceases when the water in the cup is entirely eliminated. Therefore, the only solution for the recovery of walls affected by the action of salts is the elimination of water.

[55] Cf. G. Fanfoni, *"Il restauro della sama'khana dei Dervisci Mevlevi,"* Cairo, 2006, pp. 28, 29.

[56] However, on the external front of the monument facing the street, measurements taken with an electric hygrometer on the wall surface up to 6–7m (8m for the minaret) give values that vary widely from 40% to 95%. This variability makes the stone surface appear to have a spotted surface, due to the ventilation, which dries the surface according to the stone's nature and porosity and, in particular, the presence of non-absorbent black crusts.

space between one hole and the next, completing the cut by superposition of the cuts of the first and the second series. The void of the cut thus obtained is filled with a mixture in equal parts of polyester resin (or epoxy, which is more expensive) and stone powder or fine sand. It is a very expensive technique offering high safety for ancient monuments, as it does not produce vibrations.[57]

There are electric machines with a jack chain to cut walls with a maximum thickness of 100cm. and insert a bituminous sheath. Such machines are effective in compact modern walls, but in ancient and fragile structures uncontrolled vibrations might be a serious danger.

5.5 The cut for barring of rising damp in the walls of the mausoleum

In 1992 we bought a hydraulic machine for cutting, which was adapted to the technical needs of our project, the cut of wall structures thicker than 3m. I designed and produced in Egypt a blade of 3m long, so that we were able to cut the entire section of the wall.

The central wall, between the *iwan* and the mausoleum, was cut in June 1992. Thanks to the hydraulic action, activated by an electric engine (Hp 7.5) we were able to constantly control the speed of the chain: this was essential to avoid vibrations that could damage the wall structures of the mausoleum.

Generally in a well preserved wall structure the work develops in four phases:

1) the cut with a jack chain 13mm. thick, carried out in the entire wall thickness on sections of different width (from 20 to 100cm.), according to the building's characteristics and consistency;

2) washing the interior of the cut with a jet of water;

3) completion of the filling of the cut with mortar, using a special injector;

4) insertion of the damp-proof barrier, consisting of a layer of PVC;

Finally the PVC will be joined with the damp-proof layer in the pavimentation.

The cutting operation in our buildings was made more difficult by the characteristics of the wall structure, made with mortar that had low cohesion and having further deteriorated due to the prolonged action of rising damp; the material extracted by the chain was a soaked, lean mortar, similar to mud. The wall, the thickness of which varied from two to over three meters, was of the *a sacco* type, including many empty spaces; the low cohesion of internal materials caused frequent falls of stone material inside the cut with the consequent blockage of the blade. To reduce this problem we made injections on the cutting line, before the intervention, to consolidate the wall structure. These injections contained lime mortar, brick powder and a special cement to accelerate the setting, in the proportion of 1/8 with expanding and fluidifyier additives (fig. 29, photo 3, A).

After the cut, which was 13-15mm thick and was carried out on sections 20–100cm long; it was cleaned with a metal bar and compressed air, to prevent eventual internal falls of material. Then, a sheet of PVC strips[58] 10cm. wide and 8mm thick was gradually inserted in the cut, these strips were connected one to the other without interruption for the whole length of the wall, immersed in a mortar made with special cement by the Italian company, Pagel.[59]

In consideration of the thickness of the walls, injections were made in holes above and below the PVC sheet (fig. 29, photos 7, 8), to ensure the spreading of the mortar. It was thus possible to create an uninterrupted *cordolo*[60] with the double purpose of barring humidity and consolidating the wall structure, which is also effective in the case of earthquakes, as attested during the earthquake of 1992.[61]

Special ribs on the PVC sheet made it possible to fasten the mortar tightly, the mortar incorporated the sheet and spread upwards and downwards to fill up the cavities in the wall structure (fig. 30).

After the earthquake in October 1992, and considering the good results we obtained in the static consolidation of the building, the intervention went on gradually in the whole mausoleum and in the *madrasa*.

5.6 Consolidation of wall structures

The mausoleum was built of stone, using the *a sacco* technique, up to approximately 4.5m in the north and south walls and up to 8m in the west wall; the east wall, containing the *mihrab*, is largely built of bricks. The upper part and the dome are also made

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[57] Cf. G. and I. Massari, *op. cit.*, pp. 86–88.

[58] The strips produced by Umiblok, of a specific length, consists of a section composed of a mixture of PVC and organic and inorganic lead and calcium salts with the following characteristics: specific gravity 1.5 kg/dm^3; glow wire IEC, 950°C; self-extinguishing; ultimate tensile strength 435 kg/cm^2; yield strength 460kg/cm^2; flexural modulus 30,000 kg/cm^2.

[59] We used premixed Pagel, "Ancorfix 707", injection mortar without chlorides or inerts, composed of ferric cement with an expanding additive and fluidifyer additive.

[60] The *cordolo* is a constructive element of old and new buildings. Located at each floor, it is built around the perimeter of the floors to act as an intermediary between the walls below and above. The *cordolo*, in wooden elements or particular brick textures and today frequently in reinforced-concrete, has the aim of distributing the load of the building above, but also to sew together the upper and the lower part of the masonry, so to keep the structures linked against settling events or particular stimuli, such as those generated by an earthquake.

[61] According to a specific note of Eng. Massari, the applicability of a mechanical cut and a horizontal waterproof layer in seismic areas was checked through experimental comparative tests, on tuff wall panels, isolated with a mechanical cut and horizontal waterproofing. Seismic action was simulated through cross solicitations on the panels to ascertain whether the cut and the materials introduced into it might reduce the resistance to translation. Tests carried out in November 1988 for the Technical Office of the *Commissariato di Governo* of Naples, did not point out any difference in static behaviour between treated and non-treated panels.

of brick. The interior of the mausoleum is entirely plastered, while the façade, up to 8m is made of quarry-faced ashlar and the upper brick part is plastered.

The information and experience acquired during the restoration of the *sama'khana* were useful for the consolidation of wall structures in the mausoleum. The outline of settling in the *sama'khana* shows its connection with the previous structures of the *madrasa* and their interaction in the process of decay: the whole south wall of the *sama'khana*, which is part of the madrasa and linked to the *iwan*, shows damage due to horizontal shifting, caused by a shift westward of the foundation ground (see especially the crack on the south side of the big arch of the *iwan*, fig. 31). The same problem affects all the buildings in the area and clearly has a geological nature: the presence of the *Muqattam Hills* to the east and the *Birkat al-Fil* (the pond with its deposit ground) down to the west shows that the foundation ground of the building is not homogeneous, and the movement of leaking water in the area increases this condition. The interventions thus aimed at fastening together the different structural parts, although allowing certain elasticity, so that the elements can adapt and settle together homogeneously.

For this reason, tie rods were inserted in the wall thickness to tie the structural parts and keep them together even in case of deformation due to foundation settling, earthquakes or other kinds of vibration. Tie rods (ø 37mm) were placed at the height of the springer of the dome, along the four sides, on the east and west sides rods continued inside the *iwan* fastening together all the wall sections (fig. 32). Tie rods were placed also at the base, at the height of the cut barring humidity. Anchorage of the chains was realised with bolts fixed on sectors of iron bars with C section or fixed on plates with radial ribbing, according to the texture of the wall.

The walls presented several vertical cracks at all heights up to the *muqarnas* with the larger parts downward, caused by the abovementioned movement. Some deep cracks were visible in the upper section, in the space between the two bands of inscriptions (fig. 35). Some cracks, on the upper section of the inscriptions, are covered by paint and are, therefore, older than the others and are no longer expanding. Most of these are settling cracks, probably due to the numerous restoration interventions carried out in the lower part of the walls, which had deteriorated due to humidity and salts and had been plastered over several times.

Consolidating injections of lime, stone and brick powder in equal proportions were made to reintegrate the empty spaces produced by the cracks. After the first injection, to wash the crack, and another with a fixative substance made of vinyl resin 10%, we injected a very liquid penetrating mortar, also 10% vinyl, in the internal micro cracks then, with 5% of vinyl additive, a denser mortar as a fill. In the cracks of the four internal walls of the mausoleum we injected about 30,000 litres of material.[62]

Rising damp and the action of salts up to a variable average height of 6m had caused the internal plaster to deteriorate. This section of plaster is quite recent and was buttered and repaired several times, before and after the interventions by the *Comité*.[63] Particularly, up to 3m level, corresponding to the first band of inscriptions, the plaster is made of mixed mortar on a lime and black cement base;[64] while in the upper part, probably dating to the *Comité* interventions, it is made of lime mortar, except for some later repairs[65] (figg. 25, 27). All the plastering was removed up to 7m (the level of the upper inscription), and the whole wall surface received desalinization treatment, as described in the following paragraph.

Plaster above 7m, including the dome of the mausoleum, was original and was characterized by lime mortar with vegetable fibres (flax straw).[66]

The whole area was checked with a hand percussion test; all those parts showing detachment from their support were consolidated with injections of grout; 530 litres of grout were injected in total. As a general criterion, injections were made first with a mixture of water and alcohol in equal proportions to clean the internal surfaces, then with water and resin 10% to fix internal pulverization, and finally with grout (lime and marble powder in equal parts, 5–7% resin was added) of increasing density, in different phases.

In each area of intervention, injections were made starting from the holes in the lower part, proceeding upwards to the upper holes, thus ensuring a gradual and safe spread in the whole area (fig. 34). Upper holes allow air to exit during the filling operation.

5.7 Removal of salts from wall structures

Once rising damp was blocked, we proceeded with the removal of salts from the wall surface. This operation is essential to completely prevent the phenomenon of cyclic crystallization, as it would otherwise continue, fostered by variations in humidity (RH) and by general environmental conditions.

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[62]All injections, both for the blocking of rising damp and for the specific consolidation of the wall structures were carried out with the autoclave produced by our Centre during the training course.

[63] Regarding the works by the *Comité*: cf. A. Patricolo, *exercices 1915-19*, *op. cit.*, p. 81: "A l'intérieur de la salle du tombeau, de nombreuses réparations modernes menaçaient de s'écrouler e d'entraîner les restes de la frise à inscription en stuc qui les surmontait. Il a été donc nécessaire de prévenir cette éventualité en remplaçant les mauvaises maçonneries par d'autre plus soignées et en harmonie avec les anciennes."

[64] More recent cement plasters are from the interventions carried out in 1945, not included in the documentation of the *Comité*: with the commission to the builder Saad Allah Nusir of some works in the entrance door; and then, in 1954, with the internal restorations commissioned to the builder Al-Hagg Muhammad Hassan, who remade all the plaster below the first band of inscriptions and also made some interventions above the inscriptions. See note 48.

[65] Regarding studies on mortars, especially limes and cements in ancient wall structures, cf. AA. VV*, "Mortars, Cements and Grouts used in the Conservation of Historic Buildings*, ICCROM, 1982.

[66] In particular, according to the analysis, plaster is composed, in varying proportions, of a mortar with 20% $CaCO_3$+65% $CaSO_4$, 40% $CaCO_3$+50% $CaSO_4$, with silicates, brick powder and flax straw; cotton and hibyscus fibres are often present. The *intonachino* (finishing plaster) resulted variably composed of 25% $CaCO_3$+70% $CaSO_4$ 48% $CaCO_3$+51% $CaSO_4$, and silicates.

Twenty-eight measurements of salts were carried out on walls and stucco before the restoration interventions. In the illustrations (fig. 35) the high percentages indicate the highest salt absorbing capacity of the materials: if the absorption capacity is surpassed, salts damage materials or outflow and accumulate, becoming very thick. High percentages refer, therefore, to materials that have already deteriorated and are saturated with salts. It is important to consider the percentage of salts above the height of deterioration of the wall structures, where percentages, without rising damp, are less than 1% and belong to the original building materials; they indicate the value to aim at after the removal of salts from wall structures.

In some places, the accumulation of salts was 4cm thick (fig. 82 A). The first step of the intervention to remove the salts was therefore carried out with mechanical tools such as metal tools, chisels and toothed spatulas, then with brushes. Walls were finally buttered with clay; the water in the clay dissolved the salts, which were gradually absorbed by the clay; when this dried, it was removed from the wall. The absorption and removal of salts was carried out several times and therefore took quite a long time.

At last, for deeper action, the walls were plastered with washed sand and lime lean mortar, this plaster was removed after three months when it was saturated with absorbed salts. This operation had to be performed three times before plaster could be buttered without producing any salt bloom.

This operation aimed at stabilizing the salts in the walls, as it was impossible to remove them completely from structures thicker than 2m, which were saturated with salts.

5.8 Necessary maintenance after the removal of moisture

As we could attest during the work in the *sama'khana*, the recovery of a monument afflicted by salts, caused by a prolonged lack of maintenance, requires different interventions in the course of the years to reach stabilization and the definitive neutralization of the action of salts. Massari attested that in Rome a wall 80cm thick needs five years to dry out after the cut, while in Venice the estimate is nine years.[67]

The elimination of the negative action of salts from the *sama'khana* required almost 15 years of localized interventions. Indeed after drying, there are still moisture spots with salt efflorescence on the walls. These spots are not due to humidity linked to the base of the wall, which was once the origin of the rising damp. They appear in the process of drying the walls, in correspondence to wall sections with a high percentage of salts (fig. 36). The stability of sodium chloride, in its possible combinations with other salts, is around 76% of relative humidity (RH); above and below this liquescence line, it loses or reaches crystallization.

This alternation activates the diffusion of salts and the formation of efflorescence on the surface. To interrupt this process, we had to remove and remake (even more than once) the plaster and in some cases we had to remove part of the wall in depth, as it was not possible to recover it.

On the basis of the acquired experience, we can predict that interventions for a period of 15–20 years will be necessary for the mausoleum to reach a definitive level of stabilization. Walls, in some places thicker than 3m, will undergo a slow drying process accompanied by an outflow of salts that requires localized intervention. On the other hand, the walls, up to 7m, are made with mortar containing a small quantity of lime and composed mainly of clay loam, which therefore contains a large quantity of absorbed water (see 7.1, note 110).

The analysis made with the ponderal method[68] showed that before the block of humidity in 1992, the mortar at ground level, which was completely soaked, had a percentage of water of 28% and that at the level of 1.5m the mortar had 23%. In August 2008, at 1.50m, the result of the measurement of water is 19%. This reduction of 4% in three years can give us an idea of the time required for the wall to dry, since the ideal percentage should be 6%.[69]

Regarding surface measurements, we obtained lower values on the exterior, with a variability of 20–80% against the 40–95% before the cut, but they are much reduced in the interior where, thanks to the removal of salts and the application of new plaster, condensed humidity has been reduced noticeably and measurements give a variability of 2–10% against the 70–95% before the cut. Only the original stuccoes on the lower band, where the removal of salts through clay or new plaster was not possible,[70] at some points reach values of 40–50%, which are very low, anyway, and will diminish further as the wall dries completely. The internal RH of the mausoleum, in September 2008, was reduced to 45, 60% (values refer to the day, with aeration, and at night, when it is closed), compared with the more than 80% before the dehumidification intervention (see 5.3 Humidity in the mausoleum).[71]

The drying of the walls proceeds from up to down and from outside to inside. After a few months of the intervention, the difference of humidity between the parts above and below the cut (fig. 81 B-C) was remarkable; of course the internal part of the wall still has a high percentage of water.

After the period of maintenance care necessary to the drying and stabilization of salts, the building will resemble modern buildings where rising damp is absent and eventual humidity problems will concern only condensation phenomena.

Therefore maintenance, as is currently happening for the *sama'khana*, will mainly concern aeration of the rooms, to prevent stagnation of damp air and big differences with external temperature.

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[67] Cf. G. and I. Massari, *op. cit.*, pp. 288, 289.

[68] The ponderal method consists of measuring the quantity of water actually present in a sample, resulting from the difference between the weight during the sampling and after it is dried in the oven.

[69] See note 53.

[70] The moisture in the application would have caused them to disintegrate completely.

[71] Underneath the *sama'khana*, where we had to preserve the central courtyard and the related archaeological remains, in a completely flooded area, RH is still about 75–80% and it was therefore necessary to create a ventilation and aspiration system to clear the air.

5.9 The sarcophagus of Hasan Sadaqa

Inside the mausoleum were four wooden sarcophagi. The first, of Shaykh Sadaqa, near the *mihrab,* is the biggest, 2.15 x 1.45 x 1.10m high (and 1.90m high with the cover added by the Mevlevi).

Made of cedar wood, it is in a good state of conservation, with the exception of the lower part, which had deteriorated due to humidity. There are some restorations and colourings covering the decorations (detected with UV, figg. 88, 89); some of the decorations are missing but inscriptions are complete.

Each part of it was cleaned, recovering the brightness of the colours and inscriptions; missing parts were re-integrated with a watercolour similar to the original but in a dot pattern. In the interior, the rough wood of the sarcophagus was treated with pentachlorophenol protection (Woodserv by CMB) and then with flax oil. The terminal parts of the base, which had deteriorated due to humidity, were impregnated with epoxy resin. After restoring the decorations, all the exterior surfaces were protected with vaporization of Paraloid B72 and flax oil.

We decided that the decorations discovered with UV should be obscurely visible, as a historical aspect of the sarcophagus.

5.10 Archaeological excavations

The whole area of the mausoleum was excavated by Prof. Luisa Bongrani. We found the entrance to the tomb of Sunqur Sa'di, but it was not possible to go deeper, due to water up to 50cm above floor level, which hindered access to the crypt. During excavations, different levels were discovered under the floor of the mausoleum that were chronology related. The perimeter of the sarcophagi was constructed, in the most recent period, with reused fragments of Roman and Byzantine marble from different locations. These will be displayed in the corridor at the entrance to the mausoleum.

5.11 The marble tomb of Sunqur Sa'di

The wooden sarcophagus in the centre of the mausoleum contained the marble cenotaph of Sunqur Sa'di. The cenotaph is 2.07 x 1.26 x 0.62h m; the elements on the angles raise its height to 91cm. It was composed of side columns made of two elements, each 91cm high; on the west side there was a marble slab, that had deteriorated seriously, the other sides were made of brick. These parts were in ruins and soaked with water and salts, held up only by the wooden sarcophagus that contained them (fig. 38 F). We had to dismantle it to salvage the elements. The marble parts were desalinated by immersion in de-ionized water, changed every two days over a period of 20 days, with control of salts.[72] After cleaning, they were recomposed on-site integrating the missing parts with a plastered brick wall.

The other two wooden sarcophagi date to the Mevlevi, and measure 2.10 x 1.05m, with a maximum height of 1.40m, and 1.90 x 1.07, with a maximum height of 1.47m respectively.

5.12 Restoration of the floor

After completing archaeological excavations the whole area was paved. To avoid infiltration of water and humidity, the whole area was levelled with dry crushed stone 20–30cm thick, to protect all the materials that were not excavated. On this layer, we laid a lime concrete and on it, to distribute the load, a concrete layer (*caldana*) 5cm deep, reinforced with an electrically welded, metallic grid ø 3mm of 5 x 5cm. Then, the whole area was coated with a bituminous waterproof sheath, reinforced with polyester net. This sheath extends up the perimeter walls to join the PVC sheet inserted when the wall was cut, obtaining a total block of humidity from below (fig. 30). Finally we laid the stone floor, 4cm. thick over a moist mortar made of lime and brick powder.

The flooring was made with selected local stone, the hardness and permeability of which were tested with a "Schmidt hammer" sclerometer and a "Karsten tube," respectively. Tests included the measurement of salt content released in water. The floor in the north corridor was made with materials provided directly by the S.C.A.

5.12.1 Floor typologies

During archaeological excavations and restoration interventions we were able to examine different floor types, dating to different periods (fig. 41). Floors were generally characterized by a *dakka* pressed base of earth and stones, bricks or other building waste, over which a levelling of gross mortar of the *qusrumill* type was laid; this was composed, as were the walls, of lime, brick fragments, stones, charcoal and other materials. Over this, there is the floor, usually calcareous, made of a finer lime mortar. In the case of floors that had been remade without dismantling the previous ones, the slabs were laid with lime mortar over the extant floor, as for example at the different levels of the *iwan*.

But we also found floors that were made by laying the tiles with cement mortar directly on a sand layer; they date to interventions from around the 1950s. This technique is common in Egypt today and resembles the brick floor (*ammattonato*) that we find in Italy in rustic country houses.[73] It might be an even older technique in Egypt, originating in the use of floors built with blocks of sandstone 15–20cm thick; in this technique, sand made it easier to level the heavy blocks, which were then unified using mortar in the joints.[74]

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[72] Measurements of salts were taken with salinometer "Dist 3 Hanna."

[73] In Italy it corresponds to brick floors *(ammattonato)*. Cf. AA. VV., *Manuale dell'architetto,* CNR, 1985, Spoleto, p. F 3d. and also G. Astrua, *Manuale pratico del mastro muratore*, Hoepli, p. 206.

[74] This technique, thanks to its simplicity of execution, can be retraced in different historical periods. Cf. Philipp Speiser, *La restoration du palais Bastak,* in *L'habitat traditionnel dans les pays musulmans autour de la méditerranée*, 3, IFAO, Le Caire, 1991, pp. 822, 823.

In modern floors, made of tiles about 2cm thick, this technique is not sufficient to keep the tiles united and the floor breaks down even with a small penetration of water in the joins. This is also used for floors inside houses where, on the ground floor, the levelling sand and a black cement mortar (instead of an insulating mortar made of lime) generate condensation phenomena that are damaging for living conditions in the house and for other materials, if the rooms are used for storage. On the basis of these considerations a scheme of optimal floor (fig. 40) has been suggested that is compatible with the traditional local materials available and is therefore adaptable to the conservation needs of the buildings restored.

5.13 The lower stucco band

The interior of the mausoleum is characterized by two bands of inscriptions: one at the height of approximately 3m above ground level, the other at 7.30m, marking the beginning of a transitional zone decorated with *muqarnas*. Above the *muqarnas* section is the drum, 2.05m high and richly decorated with stucco and eight windows made of stucco and coloured glass (fig. 103).

The cleaning and restoration interventions on the stuccoes revealed the execution technique. According to analysis, the mortar is composed of gypsum, silicate and brick powder that give it a pink colour.

Mortar was buttered on the whole area to be decorated, keeping a fixed thickness. Once set, the design was outlined with a pointed tool; the traces were visible at several points. Then, following the design lines, decoration was realized by carving with metallic tools (fig. 84).

5.13.1 State of conservation

The lower stucco band was seriously damaged by rising damp and was restored several times; some parts were missing and others were already about to collapse, at the time of the *Comité's* interventions.[75]

The work by the *Comité* was carefully executed: all the original parts were consolidated, some were removed, consolidated, then remounted *in situ*. The missing parts of the inscription were not completed but some of the repeated decorations were, so that the effect was that of a homogeneous whole. All the integrations made by the *Comité* were moulded, constructed in the laboratory and mounted on the wall using mortar.

Unfortunately, the work by the *Comité* did not solve the problem of the conservation of the inscriptions: as a consequence of the destructive action of rising damp, other parts of the original stucco inscriptions were lost and even the integrations made by the *Comité*[76] had been attacked by humidity and salts (fig. 77).

5.13.2 Cleaning and restoration

The restoration of the inscriptions was very difficult, due to the presence of different forms of degradation, which necessitated different kinds of intervention.

In some cases, the stucco layer had come off the stone wall as a consequence of the accumulation of crystallized salts between the two materials; in addition the absorption of humidity deformed the stucco decoration causing it to fall, while other parts were hanging loose from the wall. In this case we fastened the stucco on the wall, according to its elasticity (figg. 44, 45).

In other cases, the stucco adhered to the wall allowing salts to transpire to the surface (*cryptoefflorescence*). This process did not cause any deformation but increased pulverization; salts almost replaced the stucco itself, which when soaked, became spongy and extremely fragile. In this situation we sprayed Paraloid B72 on the stuccoes repeatedly and in an increasing concentration, until the surface became compact. These parts were moulded and copied; the duplicate replaced the original on the wall (fig. 43).

The section with the date, peculiar to the inscriptions of this monument, was in an intermediate state of conservation, with the stucco layer partly detached from the wall. The surface was consolidated and firmly attached to the wall. Then the surface was consolidated with Paraloid B72 and copied, to have a model, which will form an essential document.

Then we proceeded with the restoration of the original stucco. All traces of the Paraloid were removed because it hinders the porous material from transpiring and cannot endure on wet stucco saturated by salts. Then, we consolidated and integrated the parts on the basis of photographs or archive documents (figg. 46, 47).

In the other parts of this lower band of inscriptions we collected all the fragments fallen or detached from the wall, we desalinized, consolidated and reinforced them with a glass fibre grid, that has a square mesh 4 x 4mm, attached to the rear. They were then recomposed on the basis of archive photographs, fixed on site and integrated were possible.

5.13.3 Integrations

The stuccoes on the lower band had greatly deteriorated. The inscriptions, taken from the *Maqāmāt* by the Iraqi poet, al-Harīrī,[77] were especially full of gaps.

The lower band, at the height of 3m, is a visual reference essential to the appreciation of the architectural proportions inside the mausoleum. Its fragmentation had led to an aesthetic deterioration of this space.

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[75] Patricolo, *op. cit.;* p. 81. "A l'intérieur de la salle du tombeau, de nombreuses réparations modernes menaçaient de s'écrouler e d'entraîner les restes de la frise à inscription en stuc qui les surmontait... Il à fallu, toutefois, démonter une partie des stucs anciens, qui ont été dans la suite plus solidement fixés et complétés des parties manquantes qui constituaient l'unique lacune dans le décor de l'intérieur du tombeau.

[76] Analysis of stuccoes revealed a presence of chalk varying from 25% to 88%, though this is also determined by previous restoration interventions and by the high content of salts.

[77] G. Canova, *op. cit.*; pp. 196–198.

The *Comitè* planned an integration of the inscription[78] but never achieved it, probably because they were not certain of its literary content.[79]

In our intervention we planned different integrations[80] (figg. 48, 107) to reconstruct the visual unity and the architectural proportions of the mausoleum.

All the salvaged fragments were recomposed *in situ* and the original parts were consolidated. Frames and repetitive decorations were thoroughly integrated with reproductions obtained from copies of the original and preserved parts. Inscriptions were completed according to photographs from texts or archives, keeping the new ones 5mm lower than the original. Those parts that were not documented were integrated according to the literary reconstruction by Prof. Canova. Missing parts were reconstructed thanks to the assistance of the calligrapher Aws al-Ansārī and to extant inscriptions. After a *spolvero*[81] of the layout of the inscription is made on a reconstructed background, letters were reproduced in negative on a level 10mm lower than the background of the whole inscription. We highlighted the rims of the letters with a groove 5mm. deeper, with the optical effect that the letter was emerging and more visible even if in negative. The lightning of the mausoleum, at the same level as the band, visually merges the original, in relief, with the lower integration, making the contrasting effect of positive and negative appear as homogeneous.

The inscription band thus appears unbroken and its essential visual function in the internal architectural space of the mausoleum is recovered (fig. 103).

5.13.4 Consolidation and protection

The intervention that blocked the action of humidity removed the origin of the moisture in the mausoleum. Now, each structural and decorative part of the building must adapt to the new conditions, mainly through the evaporation of the absorbed humidity and the stabilization of salts incorporated in the porous materials. For this reason, we chose to consolidate and trim using materials that are compatible with this process of adaptation, which also requires periodical checks and specific maintenance.

To attach pieces we used vinyl resins, because they are compatible with materials soaked by humidity and will fuse with them in the drying process thanks to their elasticity. Frames and copies of decorative elements were fastened using appropriate pins to secure them to the wall. To fill in the cracks and consolidate those parts that were deformed and pitted, we used casein. The consolidation of surfaces and the final treatment of stucco inscriptions and decorations were also carried out using casein or milk, mixed in equal proportion with limewater and 5% of vinyl resin. Coloured earths were used to colour plaster and watercolours for *velatura*, to soften the contrast between different colour tones.

5.14 The upper stucco band

5.14.1 State of conservation

The upper band, at the height of 7.3m, marks the beginning of the *muqarnas*, a transition zone between the square section of the base and the circular springer of the dome. This stucco band is approximately 85cm high; it was not reached by rising damp or damaged by the crystallization of salts. There are some cracks due to the foundation settling, but it is in a good state of structural conservation. On the contrary, from an aesthetic point of view, its state of conservation is deplorable. Indeed, the inscription is covered with thick layers of *scialbatura*[82] and paint that often completely hid the decorative motif over which they were laid (fig. 83).

5.14.2 Stucco polishing

A preliminary polishing test revealed the presence of three levels of interventions. These interventions were antecedent to the works by the *Comité*, who had already faced the problem of polishing the plaster on the stuccoes, as stated in their records.[83] Most probably, the *Comité* worked only on the lower band of inscriptions, where it also carried out restorations and integrations.

The polishing of the upper band required long and precise manual work to remove the many different layers of *scialbatura* until the original surface was reached. As stated above, the thickness of the *scialbatura* often hindered us from identifying the underlying decorations, which were a reference for the restorer. Without this reference the work went slowly.

The polishing was made possible thanks to the cooperation of 50 students from Egyptian universities, admitted to the training courses at the Centre in a period of two years (2002–2003). From a didactical point of view, this kind of practice is very useful to train both the concentration of the students and their manual skills, because when they work with chisels or similar metal tools they have to be very careful and remove the *scialbatura* without nicking the original stucco, preserving also the traces of patina previously formed on the piece. A careful and controlled polishing showed traces of the drawing of the decoration's layout (fig. 84).

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[78] Patricolo. *op. cit..;* p. 81 "… et complètes des parties manquantes qui constituaient l'unique lacune dans le décor de l'intérieur du tombeau. Il reste à reproduire les inscriptions coraniques disparues dans différents panneaux de la fries."

[79] The literary content was explained in the book by 'Abd al-Rahman Fahmi, *op. cit.,* pp. 39–63; ill. 1–24.

[80] Cf. C. Brandi, *Teoria del restauro,* Torino, 1977, p. 8: "Il restauro deve mirare al ristabilimento della unità potenziale dell'opera d'arte, purchè ciò sia possible senza commettere un falso artistico o un falso storico, e senza cancellare ogni traccia del passaggio dell'opera d'arte nel tempo."

[81] The *spolvero* is a technique for transferring the drawing from the paper to the wall: after making holes along the perimeter of the letters, the operator scatters some coloured powder on the paper; the powder goes into the holes and leaves a tracing of the drawing on the wall.

[82] Thick colouring made of lime or other materials, generally used also as surface consolidating agent.

[83] Patricolo, *op. cit.*, p. 553. "Le nettoiement partiel des stucs à l'intérieur aussi bien qu'à l'extérieur de la salle du tombeau a remis au jour les beaux contours du travail ancien que les badigeonnages répétés avaient effaces.

5.15 The dome

Above the upper band of inscriptions, a *muqarnas* section, 4m high, marks the transition to the drum. The drum, 2m high, is decorated with stucco and with eight pentagonal windows, spaced by two false windows. The dome reaches, at the end of restoration, the height of 18.65m and in the centre is a Quranic inscription[84] the diameter of which is approximately 3.85m.

5.15.1 The muqarnas *and windows*

In the middle of each side in the *muqarnas* section is a group of three windows, geometrically defined by the lines of the *muqarnas* motif. The group is composed of one hexagonal window and two parallel windows, extending downwards to reach the upper belt of inscriptions. Of these groups, only that on the north side is original (fig. 85, nn 33, 34, 9).

In particular, the hexagonal window shows trace of restoration interventions in the lower part, which was probably damaged by rain. The two parallel windows below were also damaged and many parts of the glass and of the stucco were broken or lost. Previous restorations were preserved, eliminating only the incongruous parts. Missing parts were integrated and the others were reinforced with acrylic resin (Acrilic AC 33). Glass was reintegrated with epoxy resin. We then made a model of the window and its copies, to replace the two windows on the other walls.

The two parallel windows below were damaged and very fragile; we carried out a restoration similar to the one on the hexagonal window, and a general consolidation with a glass fibre grid on the back that has a square mesh of 4x4mm. These two windows were reproduced by the *Comité* to replace those missing from the south wall.

We also copied the two parallel windows produced by the *Comitè*. The model for the reproduction was made with latex[85] (fig. 86). We changed the extant ones, aesthetically very poor and dating to work prior to that of the *Comitè* (fig. 51), thus recovering the original aspect of the mausoleum in its formal unity.

The decoration of the dome terminates, in the upper part, with two lines of pentagonal windows of the same size, 4 in the *muqarnas* section and 8 in the drum.

Only the southeast window (no. 6 on the plan) is original, but the lower part was completely restored (fig. 85). It served as a model for the design of 7 copies that we produced with the same glass typology, restored by artisans to be like the ancient ones.

The other 4 windows had been restored by the *Comité* and are in a good state of conservation and recognizable as the glass panels are of commercial type. The whole upper part of the dome, on the basis of our analysis, was decorated with selected plaster,[86] with brick powder added to give it the characteristic warm colour.

The drum presented problems of lime *scialbatura*, similar to those of the inscriptions on the upper band. The *scialbatura* over the decorations of the drum was thinner and therefore easier to remove. In the upper calotte of the dome, scales of *scialbatura* had fallen in many places.

After polishing, we proceeded with the integration of the missing parts. This mainly concerned those parts of the decoration on the perimeter of the pentagonal windows on the drum; both those restored by us and those restored by the *Comité,* which were inserted in the window opening without reintegrating the decoration on the perimeter (fig. 50).

5.15.2 Protection treatments

The upper part of the mausoleum was not attacked by the effects of rising damp, and the percentage of salts here is very low. The stucco inscriptions and the decorations on the drum and on the dome were treated with B72 (3%) to protect the surfaces and to facilitate ordinary maintenance. Then, *velatura*[87] was laid on those areas that were simply plastered. This made the colour of the interior uniform, without hiding the shades acquired in the course of time, a peculiarity of original ancient plaster.

5.16 External restoration of the dome

5.16.1 State of conservation

Most of the external plaster of the dome, on the upper calotte, was missing (fig. 96, 97). This plaster was applied by the *Comité*.[88] A reinforcing wire ø 1mm mesh, 13 x 13,[89] was inserted in the new plaster layer to ensure better resistance. A *hilal* was placed on top of the dome.

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[84] G. Canova, *op. cit.*; p. 196.

[85] Depending on the object we had to reproduce, moulds were made of RTV (Room Temperature Vulcanization) silicon to more common and cheap materials such as latex (laid on in more layers, reinforced with canvas and contained in a gypsum coat), gypsum (in the case of simple forms without undercuts or with forms in plugs) and, for direct mouldings, wax, plasticine or simply clay. Each of these materials requires special attention and skill and they are therefore useful for the training of the restorer.

[86] With gypsum percentage from 80% to 95%.

[87] Light colour, gradually diluted to see the underlying surfaces in transparency.

[88] Patricolo. *op. cit*., p. 553. "D'autre part, il y a lieu de procéder sans retard au rétablissement du crépi de la coupole qui a presque complètement disparu."

[89] Mortars of the upper calotte of the dome resulted to be composed of 16% $CaCO_3$+73% $CaSO_4$ al 40% $CaCO_3$+52% $CaSO_4$; especially ancient original mortars contain flax straw fibres. The other original external plasters, at different heights of the dome, are composed of 9% $CaCO_3$+25% $CaSO_4$, al 29% $CaCO_3$+61% $CaSO_4$, silicates and flax straw.

The external circular drum of the dome is 2.2m high, with a perimeter of 28.5m, and is characterized by the presence of 8 windows, each pair spaced by 2 false windows. The upper belt of Quranic inscriptions[90] is divided into 8 sections by rosettes, intermediate and parallel to the 8 windows below[91] (fig. 94).

This circular part is on an octagonal element, linked to the square part of the mausoleum below by another polygonal section. The external windows are the same as described in the interior, with the exception of two long windows on the south wall, which are blind because they are on a level lower than the ceiling of the *iwan*.

5.16.2 Restoration of the gratings

All the gratings protecting the windows on the outside were produced by the *Comité,* using plaster.[92] Pentagonal gratings were produced on the basis of two models and then copied. The gratings of the other windows, which are larger, were made in 2 parts. Only 2 of these gratings had to be replaced (nn. 17 and 18 in the plan in fig. 51); the others were in a good state of conservation and required consolidation only, after which they were replaced *in situ* (fig. 54).

A methacrylate plate was attached at the rear of every grating and then their edges were sealed after replacement (fig. 55). We thus ensured protection from dust and weather. In fact, the only extant pointed windows were damaged in their lower parts and it is therefore plausible that the deterioration in, and destruction of, other windows was caused essentially by the weather. Methacrylate (instead of glass) will be able to absorb every kind of vibration, in a certain range even seismic vibrations, without any damage.

5.16.3 Polishing of the decorations

The works on the exterior of the dome included polishing, consolidation and reintegration of missing parts; interventions already performed by the *Comité*, whose results were precious to us for improving our techniques.[93] Only some parts of the exterior presented the *scialbatura* found on the inscriptions in the interior. We continued and completed the polishing that had been partly carried out by the *Comité*.

Sometimes, the *scialbatura* was buttered using a very hard plaster (fig. 56 G-H) that was extremely difficult to remove. Removal was carried out with metal tools over a surface that was kept wet to make it softer. Many other parts presented an accumulation of dust that had hardened in some cases.

Polishing was performed by hand, with controlled gradual action, using a brush, washing with de-ionized water and surface-active agents (desogen, sodium laurisulphate etc.), but generally we used metal tools, spatulas or specific equipment.[94] Polishing revealed a lot of damaged and corroded stucco (fig. 56 B-F), which had to be consolidated with injections, surface sutures and integrations.

5.16.4 Restoration and integrations

The consolidation of stucco to reintegrate the cracks and to ensure its adhesion to the wall was performed, as in the interior of the dome, with injections of mortar, brick powder and acrylic resins (Acrilic AC 33), using a total of 170 litres of material.

Many parts that were reproduced and replaced by the *Comité* had fallen from the wall.[95] Apparently, mortar was not the proper adhesive as it is subject to thermohygrometric variations, and was not sufficient to keep the elements stuck to the wall. To avoid a repeat of this problem, both fallen parts (dealt with by the *Comité*, fallen and collected by us) and those we produced were replaced *in situ* using injections of lime mortar and acrylic resins (Acrilic AC 33), and where necessary, with metal pins inserted deep into the wall and then covered with stucco, to protect them from atmospheric agents and thermohygrometric variations.

Special attention was paid to the integration of geometric decorations directly on the wall; in this case the polished surface was treated with a fixative agent made of local acrylic 5%,[96] and smeared with a layer of mortar and adhesive to attach it to the wall, the thickness was then filled with mortar without additives, which is easy to model after drying. This process requires one day for each layer, as the mortar has to settle without adhering, before lying on the second layer, then on the third day we did the surface finishing. We integrated repeated parts, such as frames, reproducing the models used by the *Comité.* In case of fragmentary parts of circles and original decorations, we integrated them directly *in situ*, keeping the reconstructed part on a lower level, so that it would be easily distinguishable (fig. 57).

The missing parts of the band of Quranic inscriptions at the top of the dome were reintegrated to regain the complete architectural image of the dome. For this purpose, letters and their connections were reproduced on the basis of external and internal inscriptions and missing words were recomposed. The integration differs from the original inscription in the absence of background decoration and because letters are approximately one centimetre lower than the original (fig. 57, G-H).

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[90] G. Canova, *op. cit.*; pp. 194–96.

[91] The original stucco decorations contain gypsum from 40% to 88%, with silicates and, in some cases, carbonates.

[92] Their composition varies from 30% to 80% of gypsum and silicates.

[93] Patricolo. *op. cit.;* p. 82. "Les décorations extérieures de la coupole, Presque entièrement conservée, étaient recouvertes de plusieurs couches de badigeon te de poussière noirâtre, et leur dessin d'ensemble et de détail en était presque effacé. Un savant nettoiement, exécuté par un des plâtriers les plus habiles employés par le Service, a fait revivre ce merveilleux modèle de décoration dans tout l'éclat primitif."

[94] To facilitate the work, polishing interventions were performed with different techniques and tools, both on site and, for those parts fallen from the wall, in the laboratory. We used microsandblaster Abrasil by CPR Bresciani, microhydrosandblaster CTS 6 with abrasives (aluminum oxide) and, where possible, we used microscalpels, microcutters, ultrasound ablators.

[95] Patricolo, *op .cit.,* p. 82. "Ce travail a occasionné aussi le renforcement de toutes les parties qui n'adhéraient plus aux maçonneries."

[96] We used local acrylic resin, MC-Acryl produced by Master Chemical Technology.

5.17 The restoration of the façade of the mausoleum

5.17.1 State of conservation

The damaging effects of rising damp on the façade of the mausoleum along Shari' al-Suyufiyah are a problem that the *Comitè* had also tried to solve.[97]

The correct diagnosis, on the basis of the studies by Lucas,[98] pointed out the origin of the problem and interventions repaired the damage, but the cause of the problem was not removed due to the lack of adequate means and technologies.

By blocking rising damp at the base of the walls, we removed the main cause of deterioration of the wall structures. The level of internal humidity will gradually decrease, but the process needs to be supported by other interventions for the complete recovery of the monument.

On the façade of the mausoleum, rising damp interacted with atmospheric pollution causing the formation of black crusts on stone facings. The crusts formed on the intermediate sector of the façade including the area of the evaporation of rising damp. Crusts are less evident in the soaked lower part and in the upper part not affected by rising damp.[99] Prof. L. Lazzarini provided the diffractogram of the black layer over the stone and microscopic photographs of the thin sections (fig. 90). He pointed out that, apart from gypsum, which is the product of alteration of the stone due to the effects of pollution; all the other minerals are components of the stone itself, which is a calcarenite/doloarenite stone. The black crust persists over an older patina of calcium oxalates that deeply penetrate the stone at the points where the stone had already altered. This means that the patina probably corresponds to an older organic mineralized treatment. The black crust, on the other hand, has the classic composition of all the black crusts in polluted town centres, with probably more quartz (of Aeolian origin) than normal.

The red layer especially can be considered an original pictorial film containing red ochre. Parallel Nicol (light background) and crossed Nicol (black background) photographs and thin sections show the arenitic nature of the stone and the sulphatic (containing gypsum) nature of the black crust.

5.17.2 The cleaning

After several attempts to polish the black crusts and on the base of the section cut by Prof. Lazzarini, we planned the intervention and the acquisition of necessary equipment.[100]

Polishing was carried out using controlled sandblasting. The controlled sandblasting action permitted to identify in some places the red layer of paint on the stone (fig. 90 E). From the pictures and the description by Prof. Lazzarini, we understand that the red colouring is original, that is, it was laid directly on the stone. It might be a colouring added in 1869, when, on the occasion of the opening of the Suez Canal, all the Islamic monuments were coloured in stripes of red and yellow.[101] This colouring had penetrated the stone, which was already altered, demonstrating that the monument did not have any colouring before that date. This colouring, fragmentary at the time of the *Comitè*, is a detail to be registered but does not constitute a peculiarity of the monument. We therefore decided to continue sandblasting until we reached the most ancient patina, formed on the first alteration of the stone (fig. 90 E).

Again, different systems were used to fulfil the educational purpose of the *work-site school*. All the systems we used permitted controlled sandblasting that is, allowed the restorer to follow the action of the tool on the object to be polished. An attentive and active restorer gradually removes the black crusts leaving only the last patina layer typical of the stone not touched by sandblasting (fig. 59).

Two powerful compressors[102] made it possible to run three operating stations uninterruptedly. One of these worked with an ACF-71-coublanc SV11 mini-sandblaster, the other two with a sandblaster produced by the Centre, composed of a container with an abrasive agent mixed with water, kept in suspension by a mixer and, for the sandblasting action, with mini-spray guns CTS (fig. 60).[103]

Sandblasting was carried out using water; this reduces the action of the sandblasting but eliminates the harmful dust, and therefore facilitates the work of the restorer. In the meantime, the action of water sucks salts onto the surface and washes them off thanks to the action of the sandblasting: after blocking the rising damp this action leads to a reduction of salts accumulated on the wall (like clays and plasters spread on to desalinate internal walls).[104]

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[97] Cf. note n. 50.

[98] The studies by Lucas were already known (see note 53).

[99] For a detailed analysis of the black crusts phenomenon, see the text of the seminar held by Prof. Lazzarini, available at CIERA, and also L. Lazzarini, M. L. Tabasso, *Il restauro della pietra*, Padova, 1986.

[100] For didactic purposes, we made some tests of chemical cleaning with compresses (E.D.T.A., 50-100 gr.; sodium bicarbonate ($NaHCO_3$) 30 gr.; carbossimethilcellulose 50 gr., in a litre of water), cf. L. Lazzarini, M. L. Tabasso, *op. cit.,* p.120, and also with formula AB 57 of the Istituto Centrale del Restauro in Roma, cf. P. e L. Mora, P. Philippot, *La Conservation des peintures murales*, Bologna, 1977, p. 400. A study test with AB 57 was conducted for the degree tesi of Abd El Hamid El Kafafai, relator Prof. Abdel Zaher, of the Faculty of Archaeology of Cairo University.

[101] Cf. Amin Sami Pacha, *Taqwim el-Nil* , vol. 2, part III[a], 2[a] edition, Il Cairo, 1424 h./2003 AD, p. 832.

[102] The Mattei rotating compressor of 5.5 hp for 1460 l/min. and an ordinary compressor of 4 hp for 270 l.

[103]The abrasive used was mainly calcium carbonate, sieved to the size of 150 microns, as this could be used on the three operative stations; to enrich didactics we also used quartz sand cleaned and calibrated to 150 microns.

[104] Sandblasting with water is not recommended on walls where rising damp has not been blocked, because water, sucking salts, would reinforce the action of rising damp and the rising of salts from the foundations.

5.17.3 Integrations

After completing the sandblasting, we reintegrated the stone ashlars corroded by the action of salts. We preferred an action of integrative restoration instead of replacement of the ashlars (fig. 60). We kept the original material and avoided the shock caused by the replacement of ashlars and the consequent settling of the wall structures.

But, even more important, we gave the students the opportunity to practice in proportioning the components of mortars and in varying the addition of colouring earths to come close to the original colour of the stone. They had to smear on the mortar after washing the ashlars accurately to remove salts and then fix the dusty surface. They mixed mortar and the correct proportion of coloured earths to make the colour similar to the original; then they spread the mortar adding the right proportion of resin, to make this first layer adhere to the wall. After this, other layers of mortar, without resin, were laid gradually reducing the quantity to obtain a surface that would be easy to model once dried. The final surface of the integration could thus be modelled on a lower level than the original. A careful execution of the various phases of smearing and modelling mortar leads to the production of a material that is porous enough to transpire.

Special attention was paid to polishing and consolidating the entrance portal, fractured because of static settling. Missing parts of *muqarnas* were integrated. Then, we consolidated the wooden cover over the entrance, which the *Comité* had already reconstructed as suggested by Italian architect M. Verrucci Bey[105] (fig. 95, B-C).

5.17.4 Protective treatment of stone materials and stuccoes

All the external surfaces of the mausoleum, decorations, stuccoes and stone facings were protected with ethyl silicate (Rhodorsil RC90) by Rhone Poulenc and then with water-repellent Rhodorsil H224.

6 RESTORATION OF THE MEVLEVI TAKIYYA

6.1 The rooms of the convent (section E)

6.1.1 State of conservation

The building of the convent rooms is in front of the *sama'khana*, around a garden with a fountain in the middle. The area covered by the building is 570m^2 in a total area of about 1000m^2. The space occupied by rooms is 375m^2 on two floors, with a total height of 6.5m. Each floor contains eight rooms, the average size of which is 3 x 6m. On the ground floor, the rooms open onto a colonnade functioning as a connecting space, as it is typical in monasteries. Its counterpart on the first floor is a balcony, where small wooden columns support the roof of the building with the typical Ottoman arches and counter-arches.

The whole building was in very bad condition; the floors and walls in the rooms on the ground floor had deteriorated because of humidity. The upper floor and the roof showed visible signs of settling and were in some places close to collapse (fig.15 E).

6.1.2 Restoration interventions

Humidity was blocked in all the walls on the ground floor. As the walls were seriously deteriorated due to the presence of salts, it was necessary to reintegrate fragile parts with a *cuci scuci* technique. Therefore, considering the thickness of the walls was only 60–65cm, we decided to bar humidity with a manual intervention called *a breccia*, complementary to the *cuci scuci*.[106]

Flooring on the ground floor was redone, both in the rooms and in the corridor. Floors were laid with local stone, selected and tested for its hardness, permeability, and salts content, as in the restoration of the floor of the mausoleum.

We preserved the original structure of the middle ceilings, but integrated them with new wooden beams to make them suitable for public use; the integration beams have been marked with a red stripe. False ceilings were cleaned and restored *in situ*. Flooring on the upper floor was made using boarding over original structures (reinforced by integrations). The original level was preserved by replacing the layer of loose loam with sawdust mortar (figg. 63, 66); in the first room toward the north-west the original layer of cane was preserved (instead of the new sawdust layer), protected by polyethylene, as a documentation *in situ* of the original section of the ceiling; on the floor above which parquet was laid.

Structures in the upper rooms were consolidated with injections of lime, brick powder and aggregates with the addition of resins. On the terminal part of the walls, after appropriate consolidation and levelling brick with lime mortar, we created a *cordolo* as a band of approximately 8cm high. It consists of four rods (12) laid flat and anchored by iron bars in the wall with vertical perforations of about 1m deep every 60cm. The *cordolo* acts as a chain, and connects the perimeter wall and distributes vertical loads of the coverage plan that rests on it. The *cordolo* links the angled walls and promotes the action of the building as box-like.

The original roof, which was badly damaged, could only be partially recovered; for the most part, it had to be remade according to its design and technique (fig. 63).

The balcony, especially, was deformed and squashed by settling and consequent adjustments, therefore, a delicate operation for the recovery of the horizontal level was carried out; it was gradually returned to its horizontal position by placing a hydraulic jack in each column, in this way preserving the original technical and structural elements (fig. 61, 64).

[105] See *Comité*, *exercices* 1930–32, *op. cit.* p. 270, "Sur la proposition de M. Verrucci Bey, il est décidé de réparer les consoles qui se trouvent sur la façade de ce tombeau, afin d'assurer leur conservation."

[106] We thus experimented, also for didactic purposes, with all the possible solutions for the removal of humidity from walls: the intervention in the *sama'khana* was conducted partly with injections of waterproof materials, to reduce the sucking section, and was then completed with the realization of air spaces; in this section of the convent we used the ancient hand technique *a breccia* and the waterproof layer of bitumen sheets; while in the mausoleum the physical barring was carried out by PVC layer with a mechanical cut, using a chain saw and blades expressly prepared and adapted to the purpose.

The wooden columns were corroded by water and squashed at the bases; they were all consolidated with impregnation by low viscosity epoxy resin and integrated with metal brackets supporting ceiling beams (fig. 64 E).

To prevent the return of corrosion at the base a special downspout was made on the balcony (fig. 61, section A-A 10); this, incorporated in the wooden section of the gallery ceiling, does not modify its original configuration.

All the joints of the wooden parts, both original and reproduced, were consolidated with metal brackets (fig. 65); all the metal parts were coated with glass fabric to guarantee their thermic insulation and therefore prevent a change of dimensions, which might be caused by local high temperatures, with the consequent cracking of the plaster coating.

The counter-arch sections, resting on the wooden columns to support the roof of the balcony, present the typical construction with wooden laths (*bogdadly*). On the north side of the balcony these laths had deteriorated so badly or were missing that it was necessary to recompose them; on the east side, even if they had been squashed and then horizontally replaced, the laths were still able to support the plaster, although seriously cracked. To preserve the original conditions as much as possible, we made injections of expanded polystyrene that incorporated their texture (*bogdadly*) and all the original materials in all their details (fig. 64, photo A). The cracked plaster was preserved with mortar in all its elements.

For the integrations and plastering of the reconstructed parts we realized a mortar similar to the original one, with lime, sand, brick powder, flax straw and white cement (instead of gypsum). In the first layer of plaster we added 10% of local acrylic resin (MC-Acryl) to facilitate adhesion to the wooden laths. On the basic texture of the laths we laid a light metal mesh, zinc-coated,[107] to obtain better adhesion of the mortar to the wood and to ensure the stability of the plaster.

Regarding casings, opening spaces were reinforced with steel frames, which were then hidden by the casings themselves. Doors were restored and preserved in their original materials and shapes.

Windows were impossible to preserve and they were, therefore, replaced, but their design has been preserved. A special device we designed and produced allows locking of the window at the desired height and when it is closed (fig. 68).

All the visible stone parts on the ground floor, on walls and columns, were polished with micro-sandblasting, which removed the numerous layers of colourings, and treated for the removal of salts; they were then consolidated and treated with ethilsilicate.

6.1.3 Archaeological survey

At present, two areas are undergoing archaeological excavation: area E0, west of E1-2, and area F1-F2, south of sector E of the convent (figg. 5, 67).

Area E0 consists of a terrace and two stairways connecting the garden on the ground floor to the gallery of the convent. The excavation conducted by Dr Matteo Gabbrielli revealed, under the floor of the terrace, an octagonal structure, probably a fountain, and lead pipes to carry water, as well as other pipes, to make it flow into a large cistern used as a well, and for the outflow of water. This cistern has a monumental structure probably referable to Sunqur Sa'di's buildings and will therefore be excavated in the future, to find its ground level. The upper part was closed with rocks to allow the flooring of the terrace. On the east side of the terrace, at a lower level than that of the fountain, a large basin was found (480 x 105 x 83cm deep), probably used by the convent. Around these structures, the excavation of area E0 was conducted in depth until the garden level was reached; thanks to this we found a closed door-space, on the southern perimeter wall. This find allowed the creation of a passage from the garden to the parking area behind the convent. This would also allow the construction of a northern entrance to the convent directly from the parking area, with disabled access.

Thanks to the excavation of area F1-F2, conducted by Prof. Luisa Bongrani, we unearthed some structures dating to the time of Aqbardi. Building F1-F2, which is 3.7m high, is a structure on the garden level connected to the convent and characterized in its lower part by 3 sandstone courses, regular, square and homogeneous, which are also present in the other parts of the convent.

Excavations inside this structure did not reveal any element referable to the Mevlevi. The presence of a ceramic oven built on the ruins of Aqbardi structures dates probably to settlements previous to that of the Mevlevi.

On the west side, where the ablution fountains are, in an open space with arches and an Ottoman false ceiling, we removed a brick and cement mortar wall (A in fig. 67/4) that dated to the restoration by Gam'iyya Khayriyya who used the area as an hospice in 1945. The Ottoman ceiling continues in the part behind the brick wall, where we found basins connected one to the other. The eastern side of this space is a retaining wall (B in fig. 67) holding in the earth that filled the room in area F1-F2, and was used to create the terrace above.

To proceed with excavations it is necessary to remove the wall and excavate the area below, to eventually reach the remains of the walls of the eastern *iwan* of the *madrasa* of Sunqur Sa'di, that were located, according to a graphic reconstruction, under this wall (fig. 8). Archaeological investigations should also be conducted in the area of the stairs, north of the F1-F2 block. It is necessary, therefore, to remove the stairs recently added to the north side. The stairs have a concrete balustrade and were constructed with reused material of different shape, proportion and size. Flooring on the upper floor of the stairs is made of concrete tiles on a layer of sand, a technique introduced into Egypt at the end of the 1950s. There are no other layers of flooring or different materials underneath it.

Basins unearthed in section F1-F2 and other findings in section E0 refer to the works described on the memorial plaque of Muhammad Galib[108] (1334 H/1915–16 AD), on which the closing of the well is mentioned, to build the terrace and the two stairways (in E0). The reference to F1-F2 is in the water carried to the mosque and in the wash basins that we found behind the wall of the ablution fountains, realized later by Gam'iyya Khayriyya.

Finally, we completed the flooring of the terraces, both in F1-F2 and in E0, with materials provided directly by the S.C.A.

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[107] It had already been used, with good results, in the dome of the *sama'khana*. Cf. G. Fanfoni, *Il restauro della sama'khana ...., op. cit.*, ill. 34–36.

[108] Cf. G. Canova, *"Le iscrizioni nel compleso dei dervisci…", op. cit.*, p. 204.

6.2 Reception areas (section G-H)

6.2.1 State of conservation

This section is the area of the convent along Shari‘ al-Suyufiyya. Its position and the presence here of the main entrance to the *takiyya* might mean that these spaces were used to receive the public. It covers an area of approximately 300m^2 on two floors, with a maximum height of 9m. The ground floor covers a narrow area, 5m wide, of 90m^2 along the street, including five shops, and it is older than the upper floor.

During the restoration works we detected three enlargements of the rooms on the first floor. They were marked by cornices along the perimeter of the ceilings that we left visible while using necessary protections (fig. 69).

The shops belong to an earlier building phase than the upper floor and they were built reusing even older wall structures.

During the construction of the upper floor by the Mevlevi, shops on the ground floor were shifted backwards cutting the façade and rebuilding the whole façade along the street, probably to create an overhang, which is typical of Turkish-Ottoman architecture.

6.2.2 Restoration interventions

The sequence of different enlargements, changes and other interventions characterizing this section of the convent has contributed to damaging the stability of the structure. There is no doubt that shifting the shops backwards has weakened the whole front of the building, increasing the static problem of the foundations.

The survey of the building revealed damage in the structure that occurred long ago and was fixed several times, there are traces of a horizontal shift caused by a foundation settling of the façade and a consequent movement of the upper floor over the shops towards the street (5, 5a in figg. 70, 71). There is therefore more stability in the part built with foundations on the garden level, to the east, at the back of the shop section.

The restoration intervention aimed at binding the structures giving the necessary support even in the foundations, without changing their structural and composition characteristics.

The vaults of shops, after the integration of cracks, have been protected on the extrados against stress and settling with a mantle of galvanized iron net in lime mortar and a coating of brick masonry.

On the front, in correspondence with the walls separating the shops, we made new foundations using reinforced concrete plinths and iron pilasters (6a in fig. 71) up to the middle ceiling (approx. 4.20 m.), where they were horizontally linked by iron I-beams on the whole west front (6b in fig. 71). On the upper floor, wooden beams support the overhanging façade as well.

Beams were treated with insecticide and supported by iron C-beams linked one to another (6d in fig. 71). They (6d) were then joined to the horizontal connection (6b, 6c in fig. 71) of the pillars (6a in fig. 71) of the new façade on one side, and to a tie rod attached to a iron plate (6e in fig. 71) placed on the outside along the whole east wall towards the garden.

On this base of iron elements placed inside the walls a iron cage was made surrounding and binding all the structures of the upper floor up to the roof, where a *cordolo* (6g in fig. 71) closes the cage and acts as a support for the roof.

During structural architectural consolidations we were careful to make the new elements distinguishable from the ancient structures. We used rods inside the walls, as is usual in consolidating interventions, but also *cordoli* at the level of the roof, with iron tie rods binding the whole building, as in the convent, section E; *cordoli* about 8cm thick were isolated from the ancient wall with a brick and lime mortar levelling.

The intervention was thus distinguished by the ancient structures giving them support without changing their static structure or causing a change in the aspect of the building. All the wall integrations were realized with modern bricks to make them clearly distinguishable. The subdivision and configuration of the rooms has been preserved, with the exception of the bathrooms.

During the excavations undergone to restore the vaults of the shops, we found walls made of sandstone ashlars of 70 x 30 x 15–20cm: these dimensions recur in Aqbardi buildings, therefore these walls, delimiting the area of Aqbardi’s garden, are probably part of the fencing against which the shops were built.

The sections of wall we found were displayed *in situ*, protected by glass windows (see photo 111 and plan in fig. 71).

At the level of the roof, in the rooms (H7, G8), we found some cornices attesting previous enlargements of the building in three phases (fig. 71). In rebuilding the upper roof we left these cornices visible by creating a protection with a window, which also functions as a roof light, thus making the restoration visible and, in addition, improving the aesthetics of the spaces.

Room G7, which was open at the top, was the entrance to this section before the enlargement of room G8. We covered it with a lamellar sun breaker, the design of which recalls that of the cover of the entrance of the *takiyya* Mevlevi in Galata (Istanbul, Turkey), but is clearly identifiable as a modern structure because of the materials and the light technique used.

To guarantee safety, as this is a public space, four doors were opened in the internal front of the *takiyya*, towards the garden. Finally, with a general restoration intervention, we also opened the south door of the gallery of the *sama‘khana* and made it an emergency door by connecting it with the floor in front of the entrance section.

7 Observations on mortars and their application

7.1 Original mortars

From the analysis carried out by our chemist on over 100 samples of wall mortar, plaster and stucco, we detected different compositions of the same mortar typology, often with a proportion of calcium carbonate ($CaCo_3$) and other aggregates of less than 1/3, indicating compositions of original mortars characterized by a relation lime/aggregates inferior to 1/5 (considering also that it is not possible to say if, and how much, extant $CaCo_3$ can originally correspond to lime). Analysis report that gypsum is often present, in different percentages, with an integrative function (see notes 66 and 89).

The composition of mortars varies also in the typology of aggregates, such as sand, brick powder, ash, charcoal, flax straw and others.

Such variety in the composition of mortars corresponds to the situation described by A. Mariette in his essay of 1875,[109] in which he lists 21 kinds of mortar that were traditional and well known at the time. Some of the mortars he lists refer to compositions which were used at the time and realized with imported materials, basically from Italy, France and Greece: selected limes, pozzuolana and cement.

Both bibliographic and direct data about the walls of our monuments say that mortars are differentiated according to their use, although with different formulations.

In foundations we find, although in different percentage, clay and carbonate mortars, with the presence of sand, brick fragments or powder (*humra*) and other material.[110] In foundation mortars gypsum is not present.

Inside walls we find above all lime, brick powder (*humra*), vegetal charcoal and ashes (*qusrumill*), but in some cases, especially with very thick walls and especially *a sacco* walls, we still find clay or loam and sand.[111]

Also, in the mortar of the walls in the lower levels of the building, which are affected by moisture, we do not usually find gypsum. In fig. 91, illustrating the skeleton of mortar, gypsum is absent in samples 1, 2, 3, 5 and 9[112] and it is instead present in 4, 6, 7, 8 and 10 (the latter is only gypsum without carbonates); gypsum is usually present in all the mortar taken above 5m. In particular the coating mortar of the external cap of the dome, referable to the *Comité*, has a gypsum/lime ratio of about 1:1, as a connective for aggregates.[113]

We must also point out that the mortars used by the *Comité* in the reconstruction of the walls of the mausoleum (fig. 35) and of the *iwan* are made of selected lime and sand, without gypsum or cement (fig. 91, photo. 5).

The mortars used for plastering are similar to those of the walls, even if charcoal elements are absent and the granulometry of sand and other aggregates is thinner. Generally, plaster was laid twice: the first is a sprayed layer that adheres to the wall but remains quite uneven, to allow the second layer to adhere, and a second one laid with the help of levelling screed (fig. 53), upon which the *intonachino* (thin plaster) is laid.

Gypsum is used in plaster, basically as an adhesion promoter, both inside and outside the building. This technique was already noted by Mariette[114] and is still used today.

In ancient plasters we usually find vegetal fibres (flax straw), as in the whole internal upper part of the dome and in most of the external plasters.

Vegetal fibres are absent in the finishing *intonachino* plasters, where the percentage of aggregates is generally lower and that of $CaCo_3$ is higher, which makes us think of a lime/chalk proportion 1:1, even without sand. In some samples from the exterior of the mausoleum, in the north section towards the minaret, gypsum is absent: it probably belongs to Mevlevi buildings, as the *intonachino* plaster inside the *sama'khana* is for the most part without gypsum, with a proportion of lime/aggregates of about 1:1, according to current European usage.

Finally, in decorative areas, inscriptions, gratings and windows, gypsum prevailed both inside and out and only in some cases did we find the presence of carbonates. Also the *Comité* used gypsum, without additions, for the gratings of the windows and the added decorations.

This difference in the components of mortars according to the building section and its functions do not seem to correspond to any fixed proportion in the compositions of mortar. They vary according to the ability of the operator and the traditional knowledge of the action of the different components:

- the interaction of lime with sand (or other silicate aggregates)
- the use of brick powder (*humra*) with lime to form hydraulic mortars (as a substitute somehow for the pozzuolana used in Italy, blast furnace wastes, calcinate kaolin, etc.) which can be used in foundations or wall sections subject to humidity;[115]
- improvement in the hygrometric quality of mortars with charcoal and ashes (*qusrumill*), especially in the presence of the action of salts inside walls and in a wet environment;
- the addition of vegetal fragments (flax straw) for the cohesion of mortars and to keep a certain elasticity;

[109] Cf. A. F. Mariette, *Traité pratique et raisonné de la construction en Ègypte*, I, Alexandria, 1875, pp. 69–94.

[110] Cf. A. F. Mariette, *op. cit.,* p. 70: in the text: 1 terra di Nilo ed 1 di calce ed eventualmmente aggiunto 1 di polvere di mattone.

[111] It is known that clay mortars with aggregates and even with lime, in the walls, are characteristic of poor houses. Cf. B. Aly, G. Albert, *Fouilles d'al Foustat*, Paris, 1921, p. 90.

[112] This mortar is from interventions later then the building of Sunqur Sa'di, see section 4 (The madrasa of Sunqur Sa'di).

[113] In a sample we found 40% $CaCO_3$+52% $CaSO_4$ + 6,22% silicates and 1,78% other (see note 66); the composition is similar to the formula of Mariette 1 lime + 1 gypsum + 1 *qusrumill*, *op. cit.*, p. 75.

[114] Cf. A. F. Mariette, *op. cit.*, pp. 86–87: He notes the use of a layer of plaster, composed of 2 gypsum and 1 lime, over which a second layer of lime plaster is laid.

[115] Cf. B. Aly, G. Albert, *op. cit.,* p. 90, note 5: "cinq parties de chaux éteinte à l'eau douce et une partie de brique pulvérisée (*astal*) constituent le meilleur mélange. Al *Hisbat*, ce mortier hydraulique a été connu et utilisé à toutes les époques".

- the use of gypsum to compensate for the shrinkage of lime and accelerate its setting.

This general trend is associated with the use of materials that are not always selected and the constant presence of salts, common to all building materials. We also noted that the different kinds of slaked lime (which we seasoned in basins for a period of six months or longer) does not give homogeneous results. According to our analysis the active lime contents are sometimes very low; inferior to 20%. This explains the frequent use of gypsum to integrate lime mortars or also in other cases only gypsum.

Nevertheless, while lime is a very effective cohesion promoter, even in a humid environment, and has a good interaction with salts, gypsum is very sensitive to humidity. Inside the mausoleum the stuccoes made of gypsum and the wall plaster had seriously deteriorated up to the height of the action of rising damp, while above that height they were well preserved.

Outside as well, even if it rarely rains in Egypt, the original gypsum elements of the dome were badly damaged. All the gratings of the dome were destroyed and remade by the *Comité*. Windows, without the protection of gratings, were destroyed by rain, as we can see in the only two extant windows, which are damaged in the lower parts (more exposed to rain), and were later restored by the *Comité*.

Generally, the south and west sides of the dome suffered the most serious damage, being subject to higher sun temperatures and therefore to the highest thermal difference between day and night. But it was especially the gypsum stuccoes on these sides that were lost. Gypsum has a slow process of dehydration and total alteration even at 30° with RH of 30–40%.[116]

7.2 Mortars used in the restorations

All the mortars of ancient buildings, although of many different varieties, are softer than the building materials they assemble and are generally more porous. Since the second half of the 19th century, with the spread of the use of cement, this normal equilibrium was destroyed and so was the natural building process. The artisan himself, diverted by the potential of new materials, forgot the necessary relationship between the mortar and the building materials to be assembled.

The *Comité* considered this new problem, as we can see from the mortars they used in the reconstruction of walls affected by humidity in the mausoleum and in the *iwan*. We can see, in the skeleton of mortars and in the analysis of materials, a composition of sand and lime mortars compatible with ancient mortars, however avoiding an improbable reproduction[117] of ancient mortars, called *qusrumill*, which was unknown to the artisans. On the same basis of these principles and purposes we carried out our interventions: we used original materials, still available today, differentiating the intervention from the original parts. It was then possible to avoid falsification of mortars and building techniques, giving other people the possibility, in the future, to study ancient original mortars uncontaminated by new materials and technologies.

Injections too, as described in paragraph 5.6, were limited to the cracks and to points where they were strictly necessary, to avoid contamination of other wall composition, we used mortars that are different from the ancient ones but of a similar quality and compatibility.

Where possible, we tried to respect the use of gypsum, at least in the reproductions of the decorations, with the addition of additives and waterproofing substances. However we avoided using gypsum as a binder in the first layer of the plaster and in the plaster itself, as humidity, still present in the walls, might have caused serious damage. The composition of the mortars we used in the restoration had, referring to general use, the proportion of lime/aggregates of 1:3, with the addition of white cement (to integrate lime and as a substitute for gypsum), so the basic proportions are 9 parts of sand, 3 of lime, 1 of brick powder and 1 of white cement.[118]

Variations were made for the injections and the integration mortars of the stuccoes and stones and for the plasters, reaching a lime/aggregates proportion of 1:1, adding white cement where necessary.

Aggregates, made of washed sand, brick powder, limestone, colourings etc., were varied according to the application. To the mortars, sometimes, vinyl or acrylic resins were added in a small percentage (5–10%), to increase adhesion and elasticity; we used vinyl resins in humid walls with a high proportion of salts and acrylic ones in dry walls with a small quantity of salts.

In the case of dry walls with a high percentage of stabilized salts, we injected epoxy resins and polyester, to prevent the reactivation of salts by injections containing water. In this case we first injected the solvent for the cleaning and then the mix of liquid resin, gradually increasing its density, as described in section 5.6 (The consolidation of wall structures). Consolidating injections with epoxy resins of low viscosity, mixed with inert dust, concerned mainly brick walls, as they penetrate better in small cracks, where water-based injections would be blocked by being absorbed by bricks and dust (fig. 16 A, illustrates the consolidation of the south wall of the *sama'khana* with epoxy resins).

In some cases, we added vegetal oils to the mortars, to increase their resistance to humidity, a method already known in ancient times and described in Vitruvio's treatise on architecture.[119] We also used mortar mixed with bitumen, mainly in the floors on the ground floor and in the roofs.[120]

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[116] Cf. J.H. Van't Hoff, Gypsum and Anhydrite. In *Zeitschrift fur Physikalische Chemie*, vol. 45, 1903, pp. 257–306.

[117] About the study possibilities of ancient mortars and the difficulties related to their reproduction, cf. I. Holmstrom, *Mortars, cements and grouts for conservation and repair. Some urgent needs of research*; and also M. Frizot, *L'analyse des mortiers antiques; problemes et resultants,* in *Mortars, Cements and Grouts used in the Conservation of Historic Buildings*, ICCROM, 1982.

[118] About proportions of lime, cement and aggregates for compatible mortars in ancient walls and the related quality tables, cf. the research by S. Peroni, C. Tersigni, G. Torraca, S. Cerea, M. Forti, F. Guidobaldi, P. Rossi-Doria, A. De Rege, D. Picchi, F.J. Pietrafitta, G. Benedetti, *Lime based mortars for the repair of ancient masonry and possible substitutes*. In *Mortars, Cements and Grouts used in the Conservation of Historic Buildings*, ICCROM, 1982, pp. 63–99.

[119] Vitruvius, Marcus Pollio, *De architectura Libri decem*. French translation: P. M. Vitruve, *Ouvres complètes*, par A. Choisy Paris, 1971.

[120] All the compositions of the mortars used were determined on the base of laboratory tests to check their properties; we made up some samples of 10 x 10 x 4cm and, after a short seasoning, we compared their permeability, hardness, adhesion capacity, colour, etc. Such tests were carried

The use of black cement was limited to some elements isolated from ancient walls. We used it:

- to build foundation plinths on which to insert pillars and metal structures;
- for mortar of the *caldane,* as layers of 5cm thickness with iron net 5 x 5 ø 0.3cm, for floors, or to isolate and protect the archaeological areas, so that they can be eventually removed to carry out further archaeological excavations;
- for mortar of the *cordolo* of about 8cm high incorporated in the brick construction, usually made at the level of coverage of buildings (6g in fig. 71) and having earthquake-proof chains to connect the walls. The usual *cordolo* of reinforced concrete have been avoided because, at a height of 30–40cm, stiffness and weight could be harmful if there is an earthquake.

These structural elements were always isolated from walls or from ancient parts with a bituminous sheath or with lime masonry of two or more brick lines. In particular, the *caldana*, the thin layer for distribution of weight, is floating and divided into areas of about 2m with elastic joints.

Mortar used for decorations, copies or integrations *in situ* were made with components that are similar to the original ones and in compositions suitable for the required manufacture.

In the composition of mortars for copies of the decorations and the gratings, with a reference to the original materials, we used gypsum with the addition of lime and sand, in the proportion of 8:1:1, and as much brick powder as was necessary for the colouring. To increase its resistance to atmospheric agents, gypsum was added with 10% of local acrylic resin (MC-Acryl); and finally we laid a waterproof coating over the copy, in the phase of mould casting.

In particular, we used sieved gypsum, depurated of sand and impurities, in the realization of stucco openwork windows inside the mausoleum, to prevent scrapes produced by sand grains during the work. In the modelling of gypsum for the windows and the insertion of glass panels we used both traditional techniques and tools and new tools, such as mills, precision tools and high speed tools such as the multi-Dremel, etc., so that we gave the restorers the possibility of improving their knowledge and experience (fig. 76).

To reinforce ancient stucco and produce copies of the repeated decorations and of the stucco gratings, made with moulds, we avoided iron frameworks, and preferred stainless frameworks such as steel, brass, aluminium and epoxy bars (fibreglass) and fibreglass meshes.

The final protective treatment was obtained with ethilsilicate, Rhodorsil RC90 (made by Rhone-Poulenc) and with water repellent protection Rhodorsil H224, as already indicated in the description of the work.

8 The work-site school

8.1 Programmes and didactic purposes

Two programmes interacted in the organization and development of the activities of the *work-site school*. The restoration of the mausoleum of Sunqur Sa'di and of the rooms (E, G-H) of the Mevlevi convent were promoted by the Directorate General for the Mediterranean and Middle East Countries of the Italian Ministry of Foreign Affairs (MAE), from October 2003 to March 2006. The Programme for Professional Training for Restoration and Archaeology was promoted by the Directorate General for Cooperation and Development of the Italian MAE from May 2002 to December 2007.

The development of these two programmes, conducted in parallel whenever possible, contributed to giving these activities the organization and the peculiar characteristics of a *work-site school*. It was also necessary to adapt the available structures, both in Egypt and in Italy, especially from the administrative-accountancy point of view, to meet the needs of CIERA in reporting to MAE for both programmes.

The teaching was delivered by docents who carried out the interventions working directly with the students, coordinators, restorers, technicians and artisans for the accomplishment of the work.

Students learned through constant practice, until the accomplishment of the intervention, and through the repetition of similar interventions, with the purpose of creating a mentality and an operative ability that can be achieved only by practicing. This is considered fundamental in the professional training of a restorer, as "*in restoration, the materials and the finalization of intervention techniques are entrusted to the ability of the restorer*", and in particular "*a good restorer can achieve good results with bad materials while a bad restorer obtains poor results even when using very good materials*."[121] And finally "*there are no good and bad materials, they become so according to the way they are used*."[122]

8.2 Practical activities and theoretical lessons

The training programme was carried out during the most meaningful moments, from a didactic point of view, of the restoration interventions. Restoration activities, on the other hand, were carried out during the whole year and for the whole period 2002–2007.

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out, as checks, also during the work, as we noted that the common materials on the market, even with the same name and of the same provenance, do not have always have the same concentrations and qualities, especially local acrylic and vinyl resins, therefore, also the percentages of use reported in this publication are purely indicative.

[121] G. Torraca, *La scienza nel restauro: modalità e risultati*, in *L'impresa del restauro*, Bologna, 1986, p. 33; G. Torraca, *Chimica fisica e meccanica. L'intervento delle scienze naturali nel restauro*, in "Anastilosi", Bari, 1987, p. 212; L. Lazzarini, M. L. Tabasso, *op. cit.,* pp. 109, 129.

[122] G. Torraca, *La scienza nel restauro...*, *op. cit.*, p. 33.

Restoration activities that were not directly involved in the training programme and were not carried out in those periods dedicated to the training were performed as curricular activities and then included in the didactics of the following phases of the training programme.

Theoretical lessons were divided into three levels: *basic lessons*, directed to artisans, *specialized lessons*, directed to coordinators and to the S.C.A. staff and, for each year of the programme, we organized *15 thematic lessons* (workshops and seminars), opened to a wider public, for scientific divulgation. These lessons, focusing on research themes and completed restoration interventions, but also on cultural and historical aspects of the work that are related to them, were refresher courses for architects, technicians and professionals and were given by experts from CFPR or other specialist institutions.

8.3 Professional specializations and operational fields

Training was developed in 3 categories of professional specializations:

- *supporting artisans* (carpenters, wood workers, blacksmiths, plasterers, painters, stone-cutters, floor tilers);
- *specialized professional figures* (stuccoes, stone materials, paintings, archaeological materials, work-site assistance, technicians for special interventions);
- *coordinating professional figures* (architects, engineers, restorers coordinator).

Professional specializations concerned different operational fields:

Stuccoes: inside and outside the mausoleum;

Stone: façade of the mausoleum and of the *iwan* in the *madrasa* of Sunqur Sa'di;

Painting: wooden sarcophagus of Hasan Sadaqa, inscriptions on the *iwan*, some maintenance interventions in the *sama'khana* and other general finishes in the mausoleum;

Archaeology: excavations in the mausoleum of Sunqur Sa'di and in the Mevlevi convent;

Archaeological materials: restoration of ceramics and other finds

Architecture:convent and mausoleum;

Survay and preliminary studies: Qusun-Yashbak-Aqbardi palace.

8.4 The organization of the work-site school

The *work-site school* was organized in collaboration with the S.C.A. It was offered to all the workers, artisans and technical staff working on the programme, both in training and restoration, with the support of the inspectorate of South Cairo. It was directed first by 'Adil'Abd al-Sattar, and then by 'Abd al-Khaliq Mukhtar.

The training programme was developed in three periods, each lasting about one year and characterized by 3 operational phases:

- course planning and assignment of coordination roles;
- lessons and training for artisans, specialists and coordinators;
- monitoring, additional lessons and conclusions.

For the operative organization of the programme we named three coordinators and assistants to the director of the programme, selected on the ground of their long and qualified experience at CIERA. The three were: architect Ahmad 'Ali Gabir, as site responsible and assistant to the director of the *work-site school*, assisted by the foreman Kodary Bashir. The restorer 'Ali Taha 'Omar, was chosen as coordinator of the restorers and assistant for the fine arts section. Finally, engineer Dina Bakhoum was selected to be coordinator of lessons in theory.

Involvement in the architectural and fine arts sections was constant throughout the whole period of the programme, while that for theory lessons was limited to class periods.

During the first phase of the programme we identified, among the staff assigned by the S.C.A., the professional figures qualifying as restorers, supporting artisans and group leaders.

More than 500 people benefited from the programme, among them 129 people joined the training programme for the entire course and received the certification of professional qualification: 3 professionals (as coordinators), 87 artisan-workers, 39 restorers.

Beside them 88 university students and 71 artisan-workers benefited from the programme for short training periods and 241 professionals interested in restoration attended refresh courses.

The final exhibition *Restorations and Restorers* documented the results of the activities carried out by each person who attended to the training programme.

In the *work-site school* people teach and learn how to operate through actually doing the work. Therefore, each participant received, as a certificate of acquired professional qualification, a document attesting the activity he or she had performed.

8.5 The Italian experts

Teachers were chosen among Italian experts who had already joined the researches and activities of CIERA in Egypt and therefore had a direct knowledge of the restoration problems on the site.

Most of the Italian teachers belong to Italian State Intitute of Art, but also to the Central Institute for Restoration; to the National Council for Research and the Italian Universities of Rome "La Sapienza," Naples "L'Orientale," Venice and Florence.

CFPR provided the studies of the project for carrying out the work, and the related training activities. In particular, the elevation drawings, the general and executive projects of the restoration of areas A-B of the mausoleum, E1-E16 of the convent and of the reception rooms H-G are by Giuseppe Fanfoni, who also directed the works with direct intervention in different fields, whenever necessary.

Archaeological surveys were carried out by Prof. Luisa Bongrani in areas B-C-F1-F2 and by archaeologist Matteo Gabbrielli in area E0-E01.

Architectural surveys of Qusun-Yashbak-Aqbardi palace were executed by architects Tonino Mattei, David Marcelli and Pinella Lena, who also gave lessons and assistance for the computer graphic elaborations during the training programme and in the preparation of the final exhibition, *Restorations and Restorers*.

The planimetric rendering of the whole area of the Yashbak Palace, produced with AutoCAD, is by architect Sara Fanfoni who also carried out the survey of the upper section of the drum of the dome in the mausoleum, setting up the AutoCAD elaborations which were then developed, together with the Yashbak palace architectural surveys, by the Egyptian staff during the training and education activities.

The study of the Arab inscriptions was carried out by Prof. Giovanni Canova who also gave lectures and seminars on this specialized subject.

Technical assistance lessons concerning the specific restoration fields were given by: Vittorio Campanella and Nicola Flammia, experts in wood restoration, Prof. Antonio Di Silvio, expert in metals, Dr. Luigi Fanfoni, the expert in stucco and stone restoration who coordinated the polishing and consolidation works on the stone decorations of the façade of the mausoleum. Angiola Contiguglia and Giovanna Spagnuolo, provided expertise for stuccoes and ceramics; Prof. Silvano De Luca and architect Nazzareno Volpe for the technical applications of the architectural restoration, together with Marco Palma who, being responsible for the Prevention and Protection Service of CNR, also prepared a safety plan for the work-site and offered planning and executive assistance for the use of work-site tools. Eng. Francesco Retacchi offered his consultation on planning and administration and also gave lessons in the training programme.

At the CFPR direction in Italy, architect Sara Fanfoni organized and carried out the preparation and coordination activities of the CIERA programmes.

Analyses of stone materials and black crusts were conducted by Prof. Lorenzo Lazzarini, Director of the Ancient Materials Analysis Laboratory in Venice University (IUAV). Other analyses on salts and materials were conducted by Dr Enzo Francaviglia and Dr Rosario Platania of CNR.

All other chemical analyses on mortars, stuccoes, fabrics and other building materials were conducted at CIERA by chemist Giuseppe Scala and also functioned as training in the educational activities of the *work-site school*.

APPENDIX
The inscriptions in the mausoleum of Sunqur Sa'di

Edited by Giovanni Canova

The inscriptions of the dome interior

The Central tondo (fig. 78 A)

Koran, sura of the Cow, 2 : 255 (the verse of the Throne)

1. In the name of God the Merciful the Compassionate. God! There is no god
2. but He, the Living, the Everlasting. Slumber seizes Him not,
3. neither sleep. To Him belongs all that is in the heavens and the hearth.

The upper inscriptions band (fig. 80)

From the* Maqamat *of al-Hariri

Maqama sawiyya (xi)

In the name of God the Merciful the Compassionate.
1. «Let those who work, work for an end like this. Now take thought, o ye negligent, and gird yourselves, ye slothful,
2. and look well, ye observers. How is it with you that the burying of your fellows grieves you not and that the pouring in of the mould frightens you not; that ye heed not the visitations of misfortune; that ye prepare not for the going down
3. to your graves; that ye are not moved to tears at the eye that weeps; that ye take not warning at the death-message when it is heard; that ye are not affrighted when an intimate is lost; that ye are not saddened when the mourning assembly is gathered? One of you follows home the dead man's bier
4. but his hearth is set towards his house; and he is present at the burying of his kinsman, but his thought is of securing his portion. Ye have sorrowed over your riches, if but a grain were notched away, yet have ye been forgetful of the cutting off of your friends». Oh God, let us die Muslims!

The lower inscriptions band (fig. 77)

From the* Maqamat *of al-Hariri

Maqama tinnisiyya (xli)

1. «Poor is the son of Adam, ay, how poor! He relies upon the world, on that which is unreliable, and through his love for it he is slaughtered thereby without a knife. He is addicted to it through his folly, and is rabid after through his wretchedness,
2. he hoards up in it through his boastfulness and makes no provision from it for his future state! If the son of Adam were wise, he would not revel in drinking-bouts,
3. and if he bethought himself of what went before, he would weep blood! And if he were mindful

Mihrab

4. of the requital, he would strive to overtake that which escaped his grasp, and if he looked at the issue he would better the turpitude of his actions!
5. O wonder of all wonders at him who plunges into the abode of fire, while he treasures gold and hoards up riches for his
6. descendants! Again, it is of marvels unheard-of that, though the interspersion (sprinkling) of hoariness warn thee, and thy sun proclaim its setting, yet thou seest not fit to turn, and to cleanse thee from thy blamefulness.»

We confide in your mercy, o God! God bless our lord Muhammad and his family. Dated year 721.

The inscriptions of the dome exterior

The drum inscriptions band (fig. 94)

Koran, sura of The Cow, 2 : 255 (the verse of the Throne)

1. [In the name of God the Merciful the Compassionate. God. There is no god
2. but He, the] Living, the Everlasting. Slumber seizes Him not,
3. neither sleep; to Him belongs all that is in the heavens and the earth.
4. Who is there that shall intercede with Him save by His leave? He knows
5. what lies before them and what is after them, and they comprehend not anything of His knowledge
6. save such as He wills. His Throne comprises the heavens

7. and earth; the preserving of them oppresses Him not; He is the All-high

8. the All-glorious. (256) No [compulsion is there in reli]gion. Recti[tude has become clear] from error...

The inscription of the east tondo (fig. 58, n. 22)

1. *…God (*Allah*)*

The inscription of the south window on the iwan (fig. 102)

*2. The power belongs to God (*al-mulk lil-lah*)*

The inscription of the Hasan Sadaqa sarcophagus (fig. 89)

The upper band

Koran, sura of the Cow, 2 : 255 (the verse of the Throne) - 257

In the name of God the Merciful the Compassionate.
1. God! There is no god but He, the Living, the Everlasting. Slumber seizes Him not,
neither sleep. To Him belongs all that is in the heavens
2. and the hearth. Who is there that shall intercede with Him save by His leave? He knows what lies before them and what is after them, and they comprehend not anything of His knowledge save such as He wills. His Throne comprises the heavens and the earth; the preserving of them oppresses Him not.
3. He is the All-high, the All-glorious. (256) No compulsion is there in religion. Rectitude has become clear from error. So whosoever disbelieves in idols (Taghut) and believes
4. in God, has laid hold of the most firm handle, unbreaking; God is All-hearing, All-knowing. (257) God is the Protector of the believers; He brings them from the shadows into the light.

The central panel (fig. 78B)

1. In the name of God the Merciful the Compassionate. "All that dwells upon the earth is perishing..." (Qor. 55:26). This is the coffin of the shaykh,
2. the noble, the devout, the pious, the worshipper, the shaykh Sadaqa, may God protect him with His mercy.
3. This on the beginning of Rabi' I, in the year 715 (= June 5, 1315).

The lower band (fig. 89)

1. In the name of God the Merciful the Compassionate. Who ordered the building of this blessed place is the Emir, the august (32 other honorary titles follow)
2. ...
3. ...
4. ... chief of the Mamlouk Emirs of the Sultan, Shams al-Din Sunqur al-Sa'di (on duty of) al-Malik al-Nasir, may God extend his happiness.

The tombstone of Muhammad Agha (fig. 79D)

1. *"Only he shall inhabit God's places of worship who believes in God and the Last Day*
2. *and performs the prayer, and pays the alms, and fears none but God.*
3. *It may be that those will be among the guided."*
4. *(...) al-Hajj Muhammad agha, the brother of the late*
5. *(...) happiness to our effendi.*

The tombstone of Muhammad Ghalib (1334 h., fig. 79 C)

In turkish language

1. Our lord Bayram   I provided for the restoration
2. I carried the water to the kitchen   the laundry and the linen
3. I took it till the mosque.   I did the restoration of the house
4. I ordered building a stair of two flights   two bathrooms we constructed
5. I covered the lid of the well   according to your orders we built
6. the fireplace for the large pots of the kitchen
the poor Muhammad Ghalib dede.

The tombstone of Hazman, 857 h. (fig. 79 B)

1. In the name of God, the Merciful the Compassionate.
2. There is no god but God, Muhammad is the Messenger of God. This has been set up
3. for the blessed act of charity by the honorable, the high, the lord, the respectable
4. the swordman Hazman Al Abu Bakri, the royal, the assisted by God, a shaykh covered with God's mercy.
5. This has been accomplished in the beginning of God's month of al-Muharram
6. in 856 H. [a456 A.D.].

ATTACHMENT

1 NOTES ON THE HISTORY OF THE RESTORATION

The concept of restoration, in its modern meaning, developed from the 18th century onwards and was analytically explained by Cesare Brandi in his *Theory of Restoration*, in 1963.

1.1.1 Origins

The culture of restoration and conservation is addressed to the witness of the human spirituality and to the multiple manifestations both material and immaterial of the human coscience.

Since prehistoric times that manifestations have involved conceptually the memory and the conservation; from the first graffiti to stop an event or an image till to the more complex practice of the burial, the care of which is addressed to remember-stay one existence. The burial, undoubtedly, is the deeper meaning, the most documented and is itself, emblematically, of primordial affirmation of the culture memory, associated with the conservation of the products therewith.

Ancient Egyptian civilization, represented the strongest expression of this culture, it was ruled by religious practices and developed in a specific social organization.

Together with proper burials, which also had to protect and preserve perishable objects of daily use, the activity of the Egyptians was linked to gigantic works the conservation of which, in the course of time, had to be ensured through building accuracy and imposing size, for example, the Pyramids or the Abu Simbel temple. Restoration and maintenance interventions concerned the building as a *sacred object,* rather than in its artistic aspects. The Sphinx itself, referable to the Pharaoh Khafre (c. 2,500 BC), underwent several recovery, restoration and maintenance interventions as a sacred object. The famous stele at its foot reminds us of when it was cleared of sand after the dream of Tuthmosis IV. Various other restorations that were carried out up to the Roman period were always due to its sacredness as the object of a renewed cult.

1.2 From Greek and Roman cultures to the Renaissance

Greek and Roman cultures paid special attention to *the artistic object as the cultural expression of a community, to be preserved in the present*. Therefore, they focused more on the subject of the work than on its artistic value. Their concern with preservation was mainly expressed in the choice of the best materials to produce the piece and to ensure its preservation in the course of time.[123] Maintenance consisted in using layers of protective waxes called *"ganosis"*; these were applied to the statues for their preservation and cyclically renewed, after washing the previous ones.[124]

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[123] Cf. M. Cagiano De Azevedo, Conservazione e restauro presso i Greci e i Romani, in *Bollettino dell'I.C.R.*, n. 9–10, 1952.

[124] Cf. P. Marconi, *Arte e cultura della manutenzionedei monumenti,* Bari 1984.

Only in the 16th century, with the Renaissance and its general interest in the artistic and cultural heritage of the past, do we have the first restoration intervention, on objects recognized as works of art. The interest was directed to the *work of art* of the past as an *object with an artistic value* that had to be preserved.

Of great importance was the *stacco a massello* (removal of the wall painting with its entire original substrate) performed on the *Resurrezione* by Piero della Francesca: this technique was already known, but in this case it was used for the first time for an intervention of large dimensions.[125]

In this period we also have restorations of ancient sculptures with integrations and completions, although they were conducted according to the taste of the time, as it happened with the *Laocoonte*, found in 1506 and restored; its arm was reconstructed as being stretched out, although it was clear that in the original it was bent.

The knowledge of theories about restoration in the 16th century was illustrated by Vasari: taking part in the events of his time, he agreed on remaking ancient works and was against completion or modernization of recent works.

1.3 From 1700 to 1900

In the 18th century attention was addressed to the work of art in its authenticity. An increase in the market for antiquities, already begun in the 17th century, caused an improvement in specific craft techniques and their related operational techniques. Venice was the centre of this market for works of art, which were modified, adapted and sometimes even counterfeited. Notwithstanding this, they developed a sort of concern towards the work of art, its identification, understanding and conservation.

The first interventions on paintings used the *strappo* technique (removal of the film painting only, keeping out the surface and the drawing [*sinopia*] of the preparation of the painting) date to this time and were performed by Antonio Contri from Ferrara. A relevant intervention was carried out by Robert Picault, who made the removal of the paint film from the board to the canvas; this was of great interest for the recovery of paintings whose wooden supports were not in good condition.

Then, always in Venice, Pietro Edwards organized laboratories, skilled workers and operational procedures and introduced the rule of the use of reversible materials, to guarantee the safety of the original materials of the work. Aware of the complexity of restoration interventions, he also proposed a school of painting restoration. Thus, the professional figure of the restorer was distinguished from that of the artist.

In the 19th century, the influence of Romanticism exalted the concept of the uniqueness of the work of art, related to the artist and to the time of its creation. Violent cleaning interventions were criticized in favour of the conservation of patina and the work of art started to be considered as inviolable. John Ruskin (1819–1879) affirmed that the work of art and architecture in particular, was enriched by the damage caused by time and degradation. This extreme point of view was opposed to the *re-establishing restoration* and *artistic integrations* theorized by French architect Viollet-le-Duc (1814–1879).

These debates opened the way to a more attentive analysis of the identity of the work to preserve and restore, leading to the necessity of *minimal intervention* and the *visibility* of restoration interventions.

The first restoration manuals were also published in the 19th century, in Germany (Koster), France (Lorenzo Bedotti) and Italy (Ulisse Forni and Secco Suardo).

In this context, the culture of restoration, already mature, set the foundation, in Egypt, in 1881, of the *Comité de Conservation des Monuments de l'Art Arabe*. The *Comité* involved many Italian members in its organization and often referred to Italian technicians and companies for its restoration and conservation interventions. It was, since its beginnings, formed by two commissions, one for the inventory and the other for the study and conservation of monuments. In the years 1913–1918 its regulations for the protection of the monuments of Arab period were revised by M. Piola Caselli, adviser to the Sultan, who also wrote the law of King Fuad I in 1918. The *Comité* performed its role until 1953 when, due to complex political changes, it was absorbed as the Coptic-Islamic section in the Egyptian Antiquities Organization (EAO). The activity carried out by the *Comité* was considerable and even today, those who are interested in the subject have to research the essential documentation in the literature and in the activities performed by the *Comité* in that period. Forty volumes of documents and technical reports attest the dedication and efficiency of the *Comité* in the conservation of Egypt's monumental heritage during more than 70 years of activity.

In the1900s, the culture of the past and its heritage had to face rapid technological innovation in every field. Industrial production of new materials acted positively but also caused damage to the environment and to works of art, leading to new and sometimes more dangerous and risks than in the past. Moreover, an increased interest in cultural heritage and related activities added to the difficulty of its protection in the context of the widespread phenomenon of commercialization of culture.

At the same time, on an operational level, the technological potential and the production of new materials for industry and building introduced techniques and materials that were not always suitable for restoration; therefore it was necessary to check the *compatibility* of materials for intervention. The increasing complexity of interventions both on the methodological and technical level made it necessary to pay attention to the education of the restorer, followed by suitable and continuing updating related to the operational aspects of restoration.

With that aim, practical lessons were already in 1876, being given at Museo d'Arte Applicata all'Industria to train artisans in the restoration and preservation of the objects stored in the museum. In 1940–1944, Giulio Carlo Argan, President of the museum at the time, founded the first "Art School" for the promotion and conservation of arts, with various sections dedicated to applied arts, including restoration.

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[125] Cf. A. Malucco Vaccaro, *Archeologia e restauro*, Milano, 1989.

Meanwhile, in 1939, responding to the same educational need, we have the foundation of the Istituto Centrale per il Restauro, directed until 1960 by Cesare Brandi. I.C.R. paid special attention, from the very beginning, to the restoration of paintings. Both institutions focused their three-year courses on practical and operational teaching

Since then, the Istituto Centrale del Restauro always directed its interest to research in this field, while other centres for restoration education developed, both public and private. In addition, national art schools have become numerous in Italy today, although many of them have recently lost their practical character. The Italian Egyptian Centre for Restoration and Archaeology (CIERA) was founded in Cairo in 1988 by the activities of teachers from Italian national art schools.

2 ESSENTIAL ELEMENTS OF THE THEORY OF RESTORATION BY CESARE BRANDI[126]

Starting from the definition of restoration: "*Restoration usually means any intervention whose purpose is to get a product of human activity back into operation*," Cesare Brandi notes that the products of human activity can be:

- "Industrial products," that is, any object with a utilitarian function (table, pan, hammer...) whose restoration gets it back into working order.
- Or the "work of art", which is that because it is recognized and *felt* to be a work of art and that becomes so from time to time in the conscience of everyone.

The work of art is then characterized by

- an "aesthetic instance", derived from its being artistic, and
- an "historical instance" as a human product related to a time and a space.

He therefore gives the following definition: "*Restoration is the methodological moment of the recognition of a work of art, in its physical substance and double polarity, aesthetical and historical, for its transmission in the future*."

Brandi affirms then that the intervention cannot be performed in an aesthetic instance but, rather, "*only on the material of the work of art that has to be restored,*" that is, we are not allowed to change the image (*aesthetic*).

Finally, "*restoration should aim to be the re-establishment of a potential unity of the work of art, if this is possible without producing an artistic or historical forgery or cancelling the traces of the passage of time on the work of art*."

The intervention operates on the material of the work, but the material has a "structure" and an "aspect" that should be preserved, in case of conflicts between the two, the preservation of aspect should be ensured.

Brandi gives two examples of this. A painting on a board where the board has become so porous that it cannot function as a support anymore: the painting will therefore be the material as "aspect", the board is the material as "structure". The other example is "a building collapsed because of an earthquake that has to be rebuilt by anastylosis. In this case we should consider as aspect not only the external surface of the ashlars but the ashlars themselves... though the internal wall structure can change... provided that the aspect of the material is not altered."

Finally, according to Brandi we should distinguish three times in the work of art.

- The *time of creative process* of the work of art, on which it is impossible to operate because it belongs only to the artist who accomplished it (the *aesthetic instance*).
- The period of *historical time* between the creation of the work of art and the restoration intervention, during which period the work of art and history interacted (*historical instance*). Abolishing this period to realize a re-establishing (of the original) restoration, might lead to the creation of a forgery.
- The third of the three times is *present time*, when the work of art is recognized as such and therefore as something to restore respecting the time of creative process and the contributions of historical time.

Brandi's restoration theory is based mainly on painting, extending its criteria to architecture; the thought develops essentially to the work of art as a product of human spirituality, although giving importance to the other factors involved in it.

Brandi's principles always had, until today, considerable influence on the debate on restoration, conservation and valorisation of cultural heritage.

3 RESTORATION AND THE CULTURE OF MEMORY

The Venice Charter (The International Charter for the Conservation and Restoration of Monuments and Sites) of 1964 is aimed at "safeguarding of future generations to face the monumental works of the peoples who, bearing a spiritual message of the past represent, in the present life, the living testimony of their secular traditions." This commitment to conservation was expanded in the Italian Charter of Restoration of 1987 to all the Cultural Heritage or the "objects of every epoch and geographical area that are of significant artistic, historic and generally cultural interest."

The spiritual message of the past in Cultural Heritage is the place of introspection and, finally, consciousness, along with the many changing activities of man for his existential project, aimed to the universe to be knowledge: so that, the conservation of tangible and intangible evidence of the spiritual message of the past is a qualifying act of human beings and is part of the culture of memory.

Art, religions and the culture of memory are characteristic aspects of humankind since ancient times and they are the first evidence of his existence. They are his interior boost to knowledge and to the organizational development of society.

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[126] Cf. C. Brandi, *Teoria del restauro,* Torino, 1977

Today, anyway, art, religions and the culture of memory are in contrast to a process of social development that considers any human activity or behaviour from the point of view of technique and planning. This process promotes, and is at the same time fostered by, technological progress starting a mechanism that does not permit any alternative and avoids any ethics or deeper problematic that are difficult to analyze.

- *Art*, which "is defined as such if recognized and felt as a work of art" (Brandi), cannot be examined from the point of view of technique and therefore only its commercial value remains, while its manifestations are always more concerned with protest, foreseeing a future of decay.

- *Religion*, the primordial impulse to know the reasons for existing things and the suffering tension of any human behaviour to a universal transcendent order, is valid only with an act of faith, when now the tangible certainties of technology cancel any existential problematic of human conscience, in favour of the individual benefits of the present, thus alienating traditions and historical cultures.

- Finally, *the culture of memory*, emblematically present since most ancient times, with the burial of the dead, is the most absurd thing from a technical point of view, from which man is only the reason and the purpose of a utilitarian technology that develops in present time-space, supported by a verifiable competitiveness.

Apart from the problematic development of modern cultures and their internal contradictions, we can affirm that *art, religions* and *the culture of memory* hide some truths that are still to be discovered and the elementary technical instruments of today are not sufficient for such an investigation. We therefore have to operate for the conservation of their traces.

They are at the origin of man himself and constitute its innermost and most mysterious part.

With the activities of our Centre we have tried to recover the monuments, as material evidence of the past, their history and the cultural values related to them.

We recovered the *sama'khana*, the most significant in the world for its geometric proportions and, with it, the symbology of the *sama'*, the Mevlevi performance, declared by UNESCO a world heritage to be preserved in its integrity.

We recovered, in this last phase of the works, all the extant documents about the mausoleum and the *madrasa* of Sunqur Sa'di, as well as of the most important part of the *takiyya*.

At the same time, with the organization of the *work-site school*, we tried to recover the teaching and learning methods of a laboratory, according to criteria always wished for at all times and in all fields, but very rarely realized.

This was supported also, against the loss of values from arid notions, by the great mystic poet Jalal al-Din Rumi, to whom the *takiyya* and the *sama'khana* refer. After writing the *Masnavi*, he concludes his huge book of moral teachings saying: "I have not written the *Masnavi* to make you repeat it only, but to put it under your feet and fly high."

Today, against the appropriation and technical exploitation of knowledge, which is often the reason for the power of man over man and over nature, the activity of the *work-site school* supports a teaching, which stems from direct on-site knowledge. Thus, it promotes a form of learning that, through effective experience, increases conscience and respect for the cultural and scientific values attained by mankind.

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30 Rising damp block: (A) levelling plaster; (B) PVC strips inserted in the cut for the whole thickness of the wall; (C) waterproof sheath fixed on PVC; (D) plaster reinforced with a galvanized mesh; (E) consolidation holes before the cut; (F) consolidation holes, after the cut; (G) lime mortar plaster.

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36 Healing treatments on the walls after the blocking of rising damp. In the east corner of the south wall of the *sama'khana* (photo A and B), after one year of the blocking carried out in 1988, humidity spots and efflorescences had formed both outside and in the corresponding area in the interior of the *sama'khana*. They appear as a band of moisture (photo A) following the ground course once covering the outside of the wall. This band is not connected to the foundations and therefore cannot be referred to rising damp; instead, it is due to action of the salts in the drying phase of the wall. Plaster with humidity salts was broken up and redone twice (photo C). Then, in 2002, some spots appeared on a very small area (photo D), which we broke up and remade; after this last intervention moisture spots never reappeared. In photo E we can see the wall completely restored, while the stone masonry close to it, which was not subjected to the barring, clearly shows the signs of rising damp. It was the same for other parts of the building such as the façade of the *sama'khana*, where, in any case, moisture spots were not connected to the ground.

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40 Scheme of the ideal floor on the ground floor: 1) lean mortar *qusrumill* type; 2) eventually a separating layer (*caldana*) with an electrically welded net; 3) waterproof sheath; 4) thermoresistant layer (expanded clay, pumice, tuff, pierced bricks, but not sand, cement or heavy materials); 5) levelling layer in lime mortar, limestone and brick powder, *humra*; 6) floor in limestone and mortar setting bed with lime.

41 Flooring typologies.

1) *iwan* of the *madrasa*: (A) light lime mortar; (B) stone floor; (C) stone floor overlapping the first with lime mortar.
2) mausoleum: (A) lean mortar like *qusrumill*; (B) lime mortar belonging to a first floor on the level of the marble perimeter of the tombs; (C) *qusrumill* type mortar and stone floor on lime mortar.
3) guest rooms G-H: (A) first stone floor over *qusrumill* covering the shops; (B) second floor over a filling and levelling with brick masonry; (C) last levelling, on which was laid a cement tile floor on dry sand.

4) guest room H2: floor remade with cement tiles on cement mortar and levelled with dry sand.
5) rooms of the convent: (A) original stone floor over lime mortar; (B) cement tile floor with cement mortar on dry sand.
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58 Circular decorations (tondoes or rosettes) of the dome. For each one of the 24 decorations: photo before restoration, reconstruction drawing and photo after restoration.

59 Polishing with controlled sandblasting was carried out until the original patina of the stone became visible.

60 Sandblasting: (A) positions with the sandblaster assembled by CIERA; (B) sandblaster ACF-71 coublanc SV11. (C-D) stone integration.

61 Views of the convent area: those parts which fell and their recovery with lifting jacks without dismantling the structure (regarding points A-B-D-E see photo fig. 64). Section A-A of the ceiling with hidden gutters, after restoration.

62 The convent pillars sector (E) had already undergone several restoration interventions; (A1-A7) relief of the stone columns and of the wooden pillars; (B1-7) differences in height between columns and pillars compared to the original.

63 The convent sector (E). Section of the original floor structure before restoration.
(A) roof structure: 1- false ceiling 1cm; 2- joist 10cm; 3- wooden floor 1.5cm; 4- canes, mats or other materials 2cm; 5 loam 15-20cm.
(B) floor structure of the gallery and of the rooms:
1- false ceiling 1cm; 2- joists 10cm; 3 wooden floor 1.5cm; 4- canes (often replacing the wooden floor), mats or other materials 2cm; 5- loam 15-20cm; 6- lime mortar 3cm; 7- limestone slabs 4cm; 8- sand 3cm; 9- cement mortar 2.5cm; 10- cement tiles.
(C) layers of the roof structure.
(D-E) integration of the ceilings with red-marked joists.

64 Lifting and fixing of the wooden pillars (see illustration fig. 61). Consolidation of the *bogdadly* structure with polyurethane foam.

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