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Conservation and Restoration of Farag Ibn Barqūq Mosque and Sabīl: Monument No.203 (Circassian Mamluk Dynasty)

Saleh Lamei Moustapha

Cairo, Egypt

Abstract: This paper discusses the systematic scientific method that was used in the restoration project of Farag Ibn Barquq Mosque (1382-1517 G), which is distinguished for its valuable building materials and ornaments. The paper shows the historical, monumental, and architectural study plan for the building, as the information related to the site and the structure were collected. An analysis was also done to building elements in terms of geometry and function. Structural stability and the existing structural condition studies were performed by defining structural deterioration reasons related to soil mechanics, soil physical and chemical condition, ground water properties, and load-bearing capability of the current structure. The paper studies the additional reinforcement needs for foundations and walls, building materials properties, and the best restoration method for the conservation of this monument.

Introduction

The Mosque & Sabīl of Sultan Farag ibn Barquq (monument No.203) built 811 H./1409A.D during the circassian mamluk dynasty (784-923 H./1382-1517 A.D.).[1] The mosque chosen for the restoration work, represent a unique historical case of Mamluk Architecture because it includes all the elements present in a great mosque but at a small scale – mosque, sabil and Kuttab (school for orphan children). The exterior and the interior of the building are richly decorated. Until 1923 the whole construction, was exactly opposite to Bab Zuwayla. The monument was dismantled and shifted to its existing location.

The paper aimed to clarify the strategy as well as the methodology of the preservation and restoration of the Mosque & Sabīl of Sultān Farag ibn Barqūq by highlighting the following major phases:

1. Historical, Architectural, Archaeological Studies including:

   Description of the monument, concluding the original construction before the dismantling of the monument according to manuscripts, endowment and references.

2. Environmental and laboratory studies:

   - The structural stability of the different components of the monuments.
   - Evaluations of the geotechnical conditions of soil.
   - Lab. Tests for chemical, physical, mechanical analysis of the different building materials such as stone, mortar and wood.
   - Site environmental studies: measurement of space temperature, wall surface temperature, relative humidity, dampness in wall, presence of electrically conductive salts as well as the chemical analysis of salts deposited on walls.

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[1] The monument has been cleaned and conserved as a partial fulfillment of a USAID Subgrant agreement for the Egyptian Antiquities Project of the American Research Centre in Egypt in cooperation with our centre.

- The assessment of the different conditions of the monument: Structural, physical, and environmental.

3. Recommendations for the scientific treatments:
   - Conservation
   - Repair
   - Restoration

Location & History:

The monument is located outside Bab Zuwayla at the intersection of Ad-Darb Al-Ahmar street leading to citadel and Radwan Qasaba in front of As-Salih Tala 'i ' Mosque leading to Sultan Hasan mosque as well as taht ar-rab' street leading originally to the Nile (Fig. 1).

Sultan al-Malik an-Nasir Zainaddin Abu-Sa'adat Farag, son and successor of the first ruler of the Circassian mamluk period, Barquq, ordered in 811/1409 the construction of a mosque at one of the most striking points in the old part of Cairo. It is the third sacral building besides the Khanqah[2][1] and a small so-called "white" mosque at the citadel[3], and which regretfully no longer exists, and which had been built in Cairo by order of Farag.

The monument receives its importance through its position: on the point of intersection of three main axes of medieval Cairo as well as the highly rich monument ornaments that renders this monument a qualitative example of its time (Fig. 2).

Before shifting the whole construction in 1923, the mosque was exactly opposite to B b Zuwayla, (Fig. 2) the southern gate of Fatimid Cairo,[4] [2, p196] which was constructed by General Badr al-Gamali – i.e. directly at the cross of the –major spine of the old city passing from north east to south west and the connection road from the Nile to the cit adel, the old Taht ar-Rab' street (today called Ahmad Mahir)[5] [3]. The mosque built by Fatimid Minister Tala 'i' ibn Ruzzik joined at the eastern side the mosque of Farag.They were separated by Qasabat Radwan street (today called al-Khiyamiya)[6] [4].

To the west side of the mosque was the so-called ' Apple House' (Dar At-tuffah), which was constructed 740/ 1339 by Prince Tuquzdamur, to which several other fruit shops were

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[2] For this building review S.Lamei, kloster (1968).

[3] Compare Hugga of Sultan Farag (abbreviated herebelow as HF). The exact name of the mosque is "al-Gami 'al-abyad bil-haush as-sultani"

[4] For this city gate review S.Creswell, MAE (1952) p.196-205

[5] This street leads from Bab Zuwayla to Bab al-kharq; it had ist name from the house (Rab'), which was built by Sultan Baibars al-Bunduqdari, but which was burnt in 721/1321, review Ali Mubarak III 50, 1348 H. - Al-Maqrizi II 100 (onwards) report about this street at their time; "The street outside Bab Zuwayla passes at the right (i.e. to the west) to the city canal (al-khalig), and at the left (i.e. to the east) to the citadel. The street was constructed a few years after the foundation of the city of Cairo. After the year 700/1300 many constructions took place here. The street ended below al-Malik an-Nasir Muhammad ibn Qala'un (693/1293- 741/1341).. at as-saliba near the mosque of Ibn Tulun; also review as-Sakhawi IV 823.

[6] In this street Prince Ridwan built a pavillon (qasaba), where shoes were sold (see Ali Mubarak III 50, 1348 H.). Probably the building at the southern part of the mosque is meant hereby.

joined[7] [5,p170] this construction was demolished, after being seriously damaged by a fire[8] [3,p93]

The multiple function of the building is written down on the reports of the chroniclers. Al-Maqrizi named it a mosque (masgid); As-sakhawi, who lived only a few years after Maqrizi, called this building in his writings "a Madrasa", namely the Ottoman era, under the rule of Governor Ibrahim Pasha (911/1583-922/1584), the mosque served at least for once as an official building for examining madrasat ad-Duhaisha. [7,8, p83] [9]

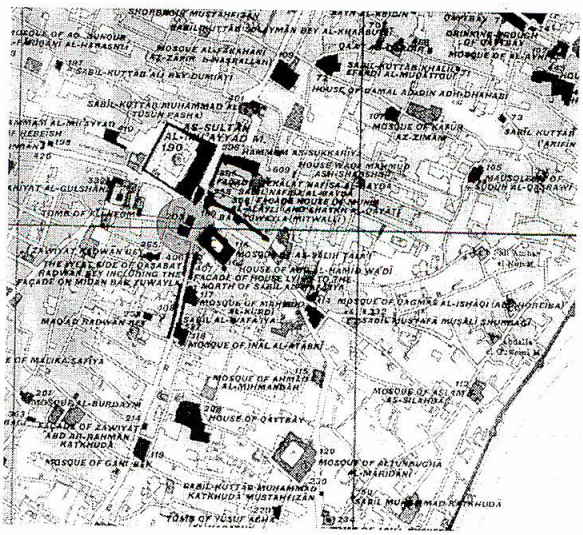


Fig. 1: Location of the monument.

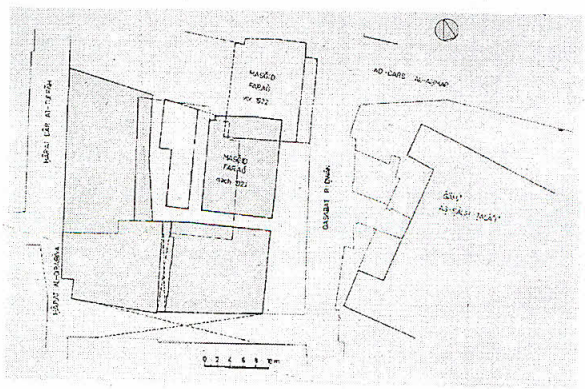


Fig. 2: Location of the mosque.

During magistrate.[10] [9,10 p57] The maintenance of this plant seems to have been insured until the donation of the constructor; the Hugga [1, p10] of Sultan Farag still bears the signatures of the leaders of the four Law Schools, dated 12 Gumada I 990 H./ 4.IV. 1582. We may also assume, that the building has been in a good state until this time.

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[7] Ibn Hagar al-`Asqalani I 170. The street between the shops was covered; the "Apple House" a hostel, is said to have been damaged by fire in 780/1378-79.

[8] Al-Maqrizi II 395-7. About the building: Creswell, Brief Chronology (1919), p. 117

[9] As-Sakhawi IV 83. A Duhaisha can be a palace, reception hall, living house (rab') or a bathing construction. Thus, there is for instance, in the citadel of Cairo and also in the Syrian city Hama a hall, both known by the name of Duhaisha (Van Berchem, CIA Egypte 1/3 (1900) 332 Notes I; Margoliouth, Cairo (1907) 108). The Hall in Cairo was constructed by Sultan as-Salih Imadaddin Isma'il ibn Muhammad ibn Qala'un 745/1344-45 according to the model of the hall constructed by al-Malik al-Mu'ayyad Imadaddin around 1320 in the proximity of Hama. The hall in the citadel of Cairo was completed in Ramadan 745/1-II. 1345. The walls were made of red and white stones (Al-Maqrizi II 212). In addition Al-Maqrizi calls a house for living purposes (rab') by the name ad-Duhaisha, it is near Bab Zuwayla (Van Berchem as above); maybe this information refers to the rab', which he built beside his mosque according to the Hugga of Sultan Farag. (III-4).

[10] Muhammad al-Bakri, al-Minah 496; Dévonshire, Rambles (1931) 57.

We do not have any information about the mosque of Sultan Farag from the two following centuries 18 & 19 th. Al-Gabarti speaks, in an interesting way, of the Sabil ad-Duhaisha; therefore we may assume that also the sabil of this mosque has been used at the beginning of the 19th century.

We have detailed information about the state of the mosque during the second half of the 19th century in the topographic encyclopedia of Ali Mubarak (1823-1893):

"Madrasat ad-Duhaisha lies opposite to Bab Zuwayla near Dar at-tuffah. The madrasa, the sabil and the school (kuttab) built on top of it were built by al-Malik an-Nasir Farag ibn Barquq under supervision of Gamaladdin Yusuf al-Ustadar. Until the present time the building is being used. The mihrab is covered with coloured marble. On top of the mosque there are apartments, the return of which was to the benefit of the building. At this time it was under supervision of Muhammad al-Qadiri.Today we know the building by the name Zawiyat ad-Duhaisha." [11, p.7]. 'Ali Mubarak mentions in the following text[12,p.43] two other tenant houses (rab), which were built by Farag outside Bab Zuwayla; yet the Hugga speaks only of one (rab), which was built at the western side of the mosque. The apartments, about which Ali Mubarak speaks, and which were on top of the building are not mentioned in the text of the deed, which means that they were originally not included. Probably they were added to the building during the 19th century.

The end of the 19th century and later preserved the kuttab on top of the sabil of the mosque – although in a bad state.[5] People spoke of the building as the "fountain of horror or of the hanged ", [11] [13, p45] probably because opposite of Bab Zuwayla many people had been hanged (Fig.2), 1922-1923, the building after discussions for many years long, was shifted 11 to 12 meters, in order to widen the street.

The Present State of the Monument

The present state dates back to two changes. There is no date for the first restoration, yet probably it is related to the fights, which took place in 1218/1804. At that time revolting Mamluks stayed in the Sabil and defended themselves against the Ottoman soldiers. The fights probably caused damages at the exterior building. The kuttab over the sabil must have been destroyed latest at this time, which must have affected also portal centrepiece of the northern facade and parts of the view-side in the east. The restoration activities immediately after this event must have been limited to the most necessary repairs.[12]

Inspite of these two building changes the original state could be reconstructed, as it is obvious by reviewing the available old photographs and the unpublished sketches, and particularly the detailed description by the Huggat Farag. This document issued only one year after finalization of the building, enabled to us to reconstruct the after building drawing. And according to this document the interior rooms, which seem to be very simply decorated, were very costly equipped (Figs. 3 & 4).

Furthermore, the Hugga reveals the presence of a small private house at the western side of the building – the Rab' ad-Duhaisha – which was built at the same time as the mosque in

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11 " Fontaine de l'effroi ou de la Pendaison"; s. Rhone, L'Egypte (1910) p.45.

12 Hereby the exterior walls were probably restored, when the first half of the Building inscription was replaced by an empty area. The portal niche was necessarily covered by a wood beam and the window to the living area H in the mezzanine was reconstructed and parts of the inscriptions were put reversed (see old photographs). Probably the stucco grids of the eastern window were also lost in this context, which were closed from the inside by means of a layer of mortar. The tile fragments above the mihrab were simultaneously replaced and a new kuttab with the living rooms in the upper floor were built.

1407-1408 and in order of the same contractor. It is probably a type previously found more often, but unknown up to this time, and that had shops in the ground floor and which had several rooms in both upper floors. In the present location there are no shops below the street (Figs. 4 & 5).

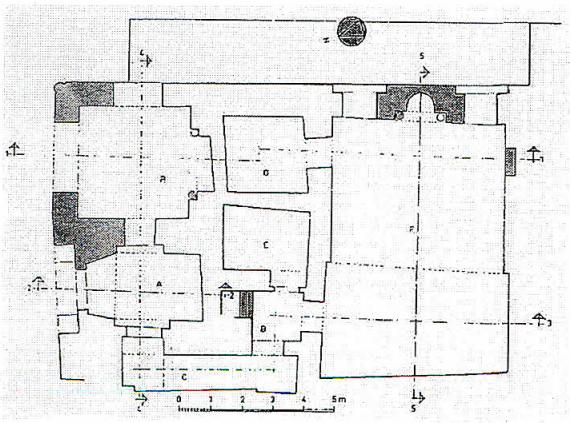


Fig. 3: Ground floor, situation 1917.

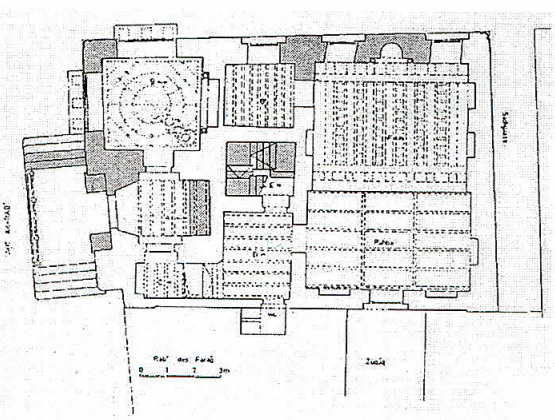


Fig. 4: Ground floor, reconstruction.

The Functions of the Monument

The monument is inspite of its small size a sacred building with several functions, which can be defined by means of exact indication in the Huggat Farag:

Masjid (F): The central part of this building was the prayers' hall (Masjid), in which prayers were held five times a day (Fig. 3).[13]

Sabil (B): The fountain, which received water by means of a cistern filled with water, had a very important role. Thus, the water cups in the Sabil were filled and given through the window too thirsty. This was done by an employee, who stayed from morning to sunset in the Sabil, with the exception of the month of Ramadan, the fasting month, during which he stayed from sunset to dawn. He was also responsible for the cleanliness of the water chamber and the drinking cups.

Madrasa (Kuttab): the room above the sabil was sacrificed for teaching the orphans children (Fig.5). The Qur'an was taught here and as condition hereto, also reading and writing.

Architectural Description

Ground Floor

The building is a cube of about 14.10 m length, 10.40 m width and 9.70 hight . The ground floor includes an entrance hall (A), a sabil (B) at the most northern corner and a prayers' hall (F), hereto connect to the north a room (G) and a staircase.On the mezzanine there is, on top of room (G) a second room (H). The walls are of limestone blocks; only the main

[13] This building was not thought to be a mosque for the Friday prayers and includes therefore in the prayers' hall neither a Minbar nor a Dikka, for which there wouldn't have been enough places in the hall. This mosque also does not have a Minaret, so that the mu'azzin would use it to call for prayers.

entrance niche at the northern side and the external walls of the sabil are covered with marble (Fig. 6).

Entrance Hall (A): The entrance hall is 2.40 x 2.12 m, 7.00 high and is covered with a wooden ceiling. The floor is covered with flagstone. It has at the north, east and West Side, a niche.

The Sabil (B): The door at the eastern wall of the entrance hall leads to the sabil. This room has a stalactite wooden ceiling. In this northern wall and in the eastern wall there is a window. In the southern wall there is a niche, which served originally as a salsabil. The floor is covered with limestone flags.

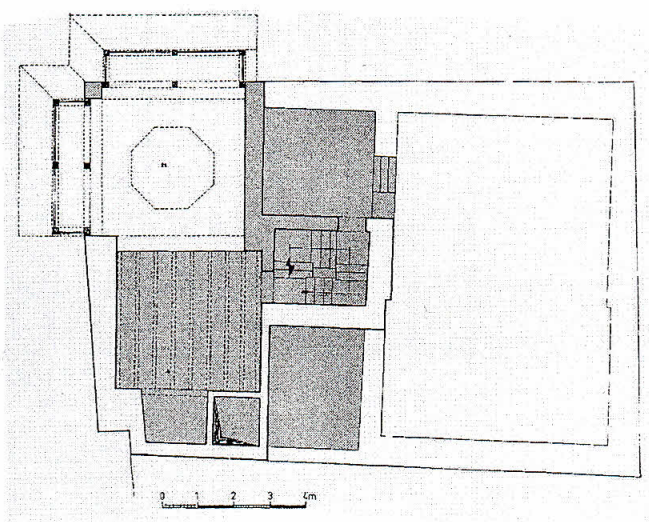


Fig. 5: Upper Floor, Reconstruction

The Salsabil-niche in the southern wall (Fig. 6) is 1.80-m wide, 0.67m deep, 5.20 m high and is 0.30 m above the floor. A hood of four wooden muqarnas rows is covering the upper part.The room (B) is covered with a fine stalactite wooden ceiling and is painted and gilded. This ceiling is suspended to another joist ceiling, approx.1.55m over it, by means of iron strips. This suspended stalactite ceiling is joined to the walls by means of wooden fries. In each corner there is a slightly round wooden niche painted with arabesques, which ends at the lower part with a lilly shape.

Corridor (c): The door at the western wall of the entrance hall leads to a 3.00 m long and 1.30 m wide corridor, covered by a wooden ceiling.

Vestibule (D): From the corridor (c) we can reach a vestibule by means of 2 steps being both 0.45m high: the northern side is 2.20 m, the eastern side 2.65m, the southern side 2.30m and the western side 2.50m.This vestibule has a wooden ceiling. The floor cover consists of lime stone flags.

Staircase (E): The staircase is 2.65 x 2.02m.The stairs consists of four flights and consists of 10 stretchers. The step and riser of limestone are 0.05-0.06m thick. The steps are 0.25-0.27m wide, the hight of the step amounts is 0.16-0.17m (Fig. 6).

The Prayers' Hall (F): the prayers' hall, contains a room (rihab) & an Iwan. The Iwan is 5.85m long, 4.84 m wide, 7.14m high and covered with a wooden ceiling. The floor is covered with limestone flags. The niche of the mihrab in the eastern wall lies in a high recess, which has a stilted pointed arch. The mihrab columns are of marble. The mihrab is covered with marble. The middle part of the mihrab incrustation consists in the center of an

area framed with wooden ledges, It is decorated with notched strips of white, black and red marble. Around this area, there is a marble panel framed by wooden beams. It is decorated with arabesque reliefs painted in red[14] (Fig. 6).

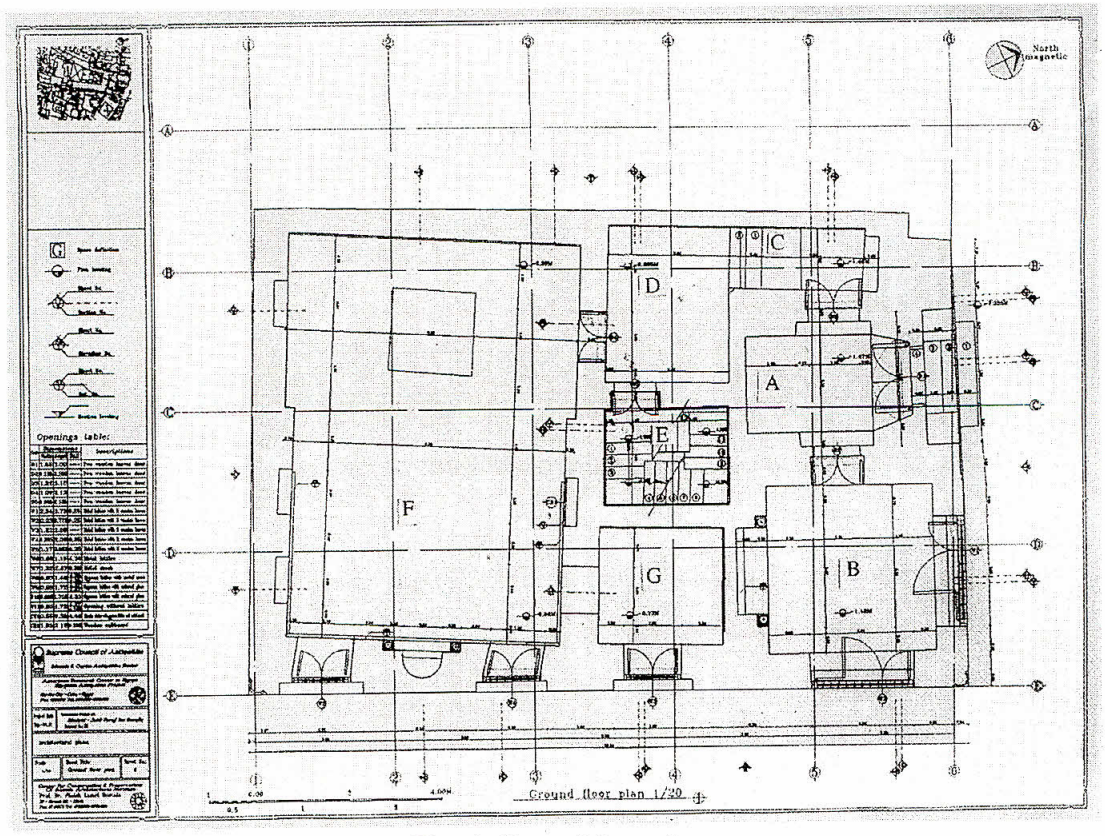


Fig. 6: Ground floor plan.

Mezzanine:

Room (H): This second room being over the room (G), which is to be reached through the staircase (E), was covered with a colour-painted wooden ceiling and there was a two-piece wooden door. The window was originally of the same shape as toady.

Upper floor:

Kuttab: Above the stairs (E), leading today to the roof, it was possible in the past – according to the document – to come through the left side to the entrance of the school space (kuttab) (A) and the sabil (B) in the north eastern corner of the building. (Fig. 5).

Both room apartments had a wooden ceiling painted with decorations; in the middle of the Iwan ceiling there was a lantern (qubbat kharkah) made of gilded wood, in which parts of coloured glass were inlaid with (gamat az-zugag al-mulawwan). The Iwan-room expanded at the northern and eastern side by means of a protruding balcony on wooden corbels (raushan), which were covered with plywood (farkh shami). These balconies were

[14] The red painting of this relief decoration leads to the assumption, that these parts were earlier in gilded.

subdivided by means of painted and gilded wooden column, which carry canopies (rafraf), which has gilded inscriptions.[15] [14, T.III]

The Cellar: The cellar, which was lost during the shift of the building in 1923 can be recaptured by means of the description in Huggat Farag and the layout of the Antiquity Authority of 1922. (Figs. 7 & 8).

Shop Areas and Corridors: The document mentions a small door below the window on the western wall of the prayers' hall (F) which gave access to an vaulted corridor (B). This corridor lead to two magazines and a niche, in which there was a basin of stone, through which the cistern could be filled with water.[16] From the corridor split a further corridor (E), which lead to a blind alley at the southern side of the building.[17] (Figs. 7 & 8)

Cistern: The cistern was annexed to the shop areas, below the Sabil (B) with neighboured rooms (sahrig)[18] the walls of which were built of burnt bricks with water proof mortar and covered with water proof plaster.

Building Exteriors (Facades)

By means of old photographs it is possible to realize, that during the far-reaching restorations or respectively the shift took place in 1922-1923, parts of the exterior wall were not reconstructed in accordance to the old state. The complete northern facade and the annexed part of the eastern facade, are today 2 stone courses higher than the fundament.[19]

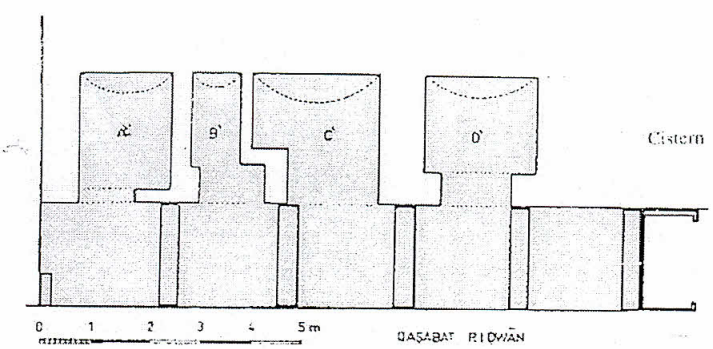


Fig. 7: Basement Floor, Situation 1911.

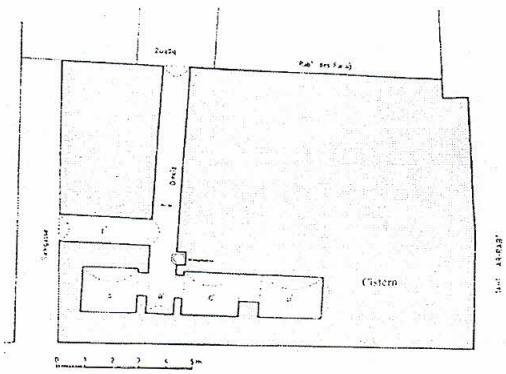


Fig. 8: basement floor, Reconstruction.

[15] The exterior appearance of the kuttab corresponds to the description of the following buildings. Monastery of Sa'd ibn Ghurab of 803/1400-808/1406 (Bulletin du Comité XXVIII (1912) T. III), Madrasa of Asraf Barsbay of 829/1425 and the Mosque of Zainaddin Yahya of 848/1444 in al-Azhar.

[16] Niches with water basins are for example still preserved in the western facade of the monastery of Farag built in 801/1399-813/1411A.D. and the monastery of Qurqumas built between 911/1506 and 913/1507A.D.

[17] Probably the corridors in the lower floor served also to join two blind alleys together, which joined at the western side of the building with the prayers' hall and that along the southern side . Hereby it would have been possible to connect Harat Dar at-Tuffah with Qasabat Ridwan street via the corridors in the cellar.

[18] The cistern was assumably partly below the entrance hall (A), corridor (C), vestibule (D), staircase (E) and even the prayers' hall (F).

[19] The original floor level of the rooms was kept. This gives reason for the 0.30 m high parapet of the sabil window (8). Yet, the hight of the ceilings was changed.

Northern Façade:

- The northern facade is 10.30 m long, the entrance niche is 2.82 m wide and 0.67 m deep.
- The niche is carved with a trefoil arch. The hood of the niche consists of four stalactite rows. The niche is covered with alternatively horizontal black and white marble block (ablaq). The entrance door is on the axis of the portal niche. The outer side is decorated with engraved in geometrical shapes and hexagonal stars. The decoration includes besides stones also red paste, flux and mother of pearl. The door lintel is framed with a marble lintel (Figs. 9 & 10).
- At the left of the entry there is a sabil-window. The window lintel is decorated at the outer side with an Arabesque-system composed of small parts.
- In the corner, the wall is mortised, inclined and displayed with an engaged column. The column has a muqarnas capital and a clock-shaped basis.

Eastern Facade:

- The eastern facade is 15.31 m long, It is composed of the eastern exterior wall of the prayers' hall with annexed rooms (G & H) and the sabil (B) (Fig. 11,12,13).
- The eastern wall of the Iwan and the annexed rooms are constructed with limestone. The window lintel, made of limestone, is decorated with arabesques grouped around a twelve-angled star.
- To the left, from the Sabil window, there are two windows in a niche, one above the other, ended with two Muqarnas-rows; the two other niches are each composed of two small niches. The windows illuminate the super-imposed rooms (G & H).
- The window lintel is decorated with a frieze composed of six deeply cut blossom shapes. This decoration is filled with red paste. The window lintel is framed with red stones. On the wall alignment between both window niches, there is a round window, which is set in a square area. The ground is covered with white marble.

Southern and Western facade:

At the southern and western side of the building there is each a narrow alley. On the western facade composed of bricks and rubble limestones, there are five windows at the upper part.

Architectural Origin

This mosque receives its importance through the founder, Sultan Farag and through its central position.

The decoration of the interior rooms results out of the tradition, such as reveals the middle area of the mihrab-niche with the Y-rows which appears also sometimes identical to the prayers' niches of the Madrasa of Mithqal[20] [15, Fig..XIII].

The building ornaments renders this building to a qualitative example of its time.As for the decorative columns of the north-eastern and south-eastern corner, they do not have a

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[20] Bulletin du Comité XXXIV (1933) P.XIII; comparable are also the crenellate fillings with Arabesque pattern and the blind niche series.

constructive, but a more decorative function as in the case with wall of the entrance niche of the Qala'un complex built between 683/1284 and 684/1285 A.C [16, Page 79][21].

There are analogies also for the decoration of this corner column. That of the north-eastern corner has a springer in the spiral torus of the monumental corner column of the entrance niche of the Sultan Hasan Madrasa[22] and that of the south –eastern corner is mostly in analogy to the corner column of the Madrasa of Gamaladdin al-Ustadar constructed in the same year.[23]

The stalactite ceilings of wood are also rare. The earliest sample available in Cairo is the palace of Bashtak built between 735 H./ 1334 A.C[24], where the basic pattern is composed of octagonals joined to each other. The pattern of the following example is more complicated, which is the wooden ceiling on the sides of the main Iwan of the Madrasa of Barquq built during the time from 786/1384 – 788/1386, which coincides with the ceiling in the Sabil of the Mosque of Farag[25].

Works of the Committee:

It is thanks to the Antiquity Authority, i.e. the "Comité de Conservation des monuments de l'Art Arabe", that this site, which is of particular importance for the history of development of the Mamluk Architecture has been preserved up to our time. Because towards the end of the 19th century the bad state of the building is reported[26] [18, p40], which was probably caused by the occupation of the building by revolutionary Mamluks and the fights related herewith of the year 1218/1804. Due to its bad state and its position which impeded transportation 'Ali Mubarak Pasha was for the demolition of the building.[27] [18, p16] In order to avoid destruction of the building, the Comité implemented between 1884 and 1887 several

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[21] Hautecoeur- Wiet, Mosquées (1932) Fig..79/I; Creswell, MAE II (1959) Fig. 66b.

[22] Hauteceour - Wiet, Mosquées (1932) Fig. 126.

[23] Bulletin du Comité XXXII (1922) P. CXXVIII.

[24] Hauteceour - Wiet, Mosquées (1932) Fig. 110/1. - A much earlier example is the Fatimid wooden ceiling of the Capella Palatina in Palermo, Cecilia, finalized around 1140; Marcais, Manuel I (1926) 194, Fig. 114. Probably, this seiling is related with the stalactite cones of North Africa, e.g. with that of the Mihrab of the Qarawiyin Mosque in Fez of 1135-1145; Marcais, Manuel I (1926) 307-313. Yet stalactite cones are known in Syria e.g. on the Madrasa Al-Ashrafiya in Aleppo built between 840/1242 and 850/1251A.D.; Creswell; MAE II (1952) 116. According to these samples it is to be assumed that stalactite ceilings in Egypt were influenced by stalactite cones in Syria or North Africa.

[25] Comparably complicated are the later wooden stalactite ceilings of the entrance hall of the Mosque Ganibek built in 830/1426-27 and in the Sabil of the Mausoleum al-Ghuri built between 909H. /1503 A.D.and 910H./1503A.D. - Regarding the wooden ceiling of the Iwan of the prayers' hall compare the ceiling of the main Iwan of the Madrasa of Gamaladdin Yusuf al-Ustadar of 811H./1408A.C. and Lamei, kloster (1968) 124, Fig. 125; regarding the niche division of the eastern facade, for clock shape capitals and octagonal pillars, as well as for interconnected stones compare Lamei, kloster (1968) 117, 122, 125.

[26] Bulletin du Comité I (2nd edition 1892) 40: Report I (I. II.1882).

[27] Bulletin du Comité I (2nd edition 1892) 16; Procès-verbal 2 (16.XII.1982).

security measures to the building.[28] [19, p14]. Since 1895 there was the plan, to demolish the tenant buildings on the upper floor above the sabil,[29] [20, Rapport 27] which took place in 1906 under leadership of M.Herz.

During the shift, or exactly after it,[30] [21, p15] the building was vigorously restored: The window of the room (H), which was later changed in the mezzanine, took the same shape as the original windows of the eastern facade reveal. Over and above the parts of the inscription frieze, which was put reversed, were put correctly. Assumably, the decoration of the interior areas were also elaborated in this context, the wooden ceiling in the Sabil and the prayers' hall were secured, and the gypsum glass lattice of the upper window row of the prayers' hall, of which only very few remainders, was added and the newly added window on the western wall with corresponding gypsum glass lattice were closed.[31] The new rebuilding of the site does not correspond in all details to the original state. During these works or during the later securings before the year 1936 [32] [21, p158], the wooden inscription plate of the eastern sabil-window was brought back to the Museum of Islamic Art.

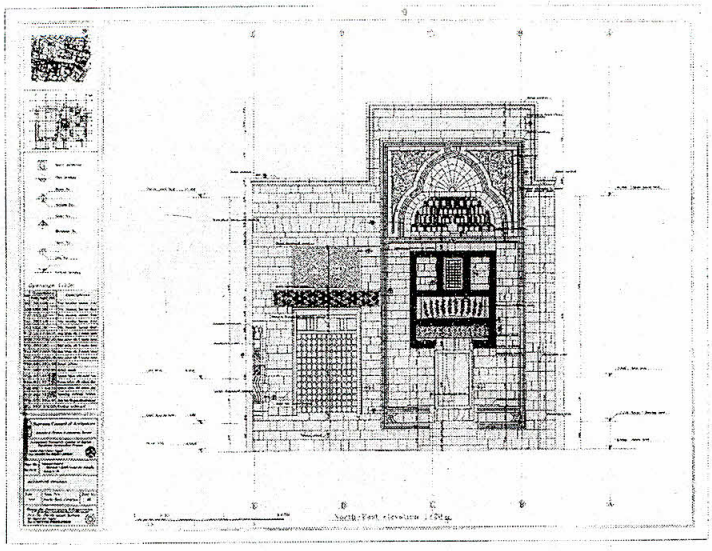


Fig. 9: North-East elevation.

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[28] Bulletin du Comité III (1886) x: Procès-verbl 14 (20.I.1885); Bulletin du Comité IV (1887) XII, XV: Procès verbl 21 (10.III.1886); Bulletin du Comité V (1889) x: Procès-verbal 26 (23.IV. 1887), XLVI: Procès-verbal 32 (9.V.1888).

[29] Bulletin du Comité VII (1896); Rapport 27 (2.II.1895); Bulletin du Comité XXI (1904) 27: Procès-verbal 129 (5. VI.1904), 44: Rapport 330 (28.III.1904). - These constructions on the upper floor are proven by means of following figures: P. Cardin by Rhone, L'Egypte (1910) Fig. p. 46; view from east; Briggs, Muhammadan Architecture (1924), Fig. 104; Hauteceour - Wiet, Mosquées (1932) T. 164 Both photographies give a view of the Darb al-Ahmar street to the west with the Mosque and Bab Zuwaila opposite to it in the background.

[30] Bigger jobs are calculated for the year 1924-25; Bulletin du Comité XXXIV (1933) 15: Rapport 608 (25.VI.1925). Acording to the private notes of Hasan 'Abdalwahhab restaurations took also place in 1928, yet they are not proven by the Bulletin du Comité.

[31] Also the windows on the corridor (C) and Vestibule (D) are part of these works.

[32] Bulletin du Comité XXXVII (1940) 158: Rapport 687 (5.VI.1934), 172: Procès-verbal 281 (19.VI.1934) 180 : Rapport 688 (25.VI.1934). 1936 is a terminus ante quem, because the Fig. was published by J. David-Weill in the catalogue of the Museum (Compare Remark 105).

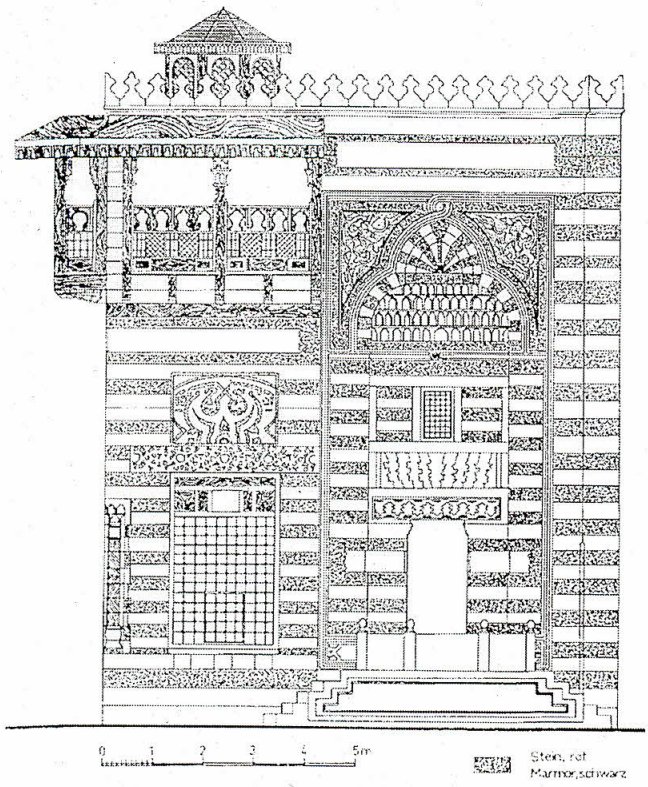


Fig. 10: North Façade, Reconstruction.

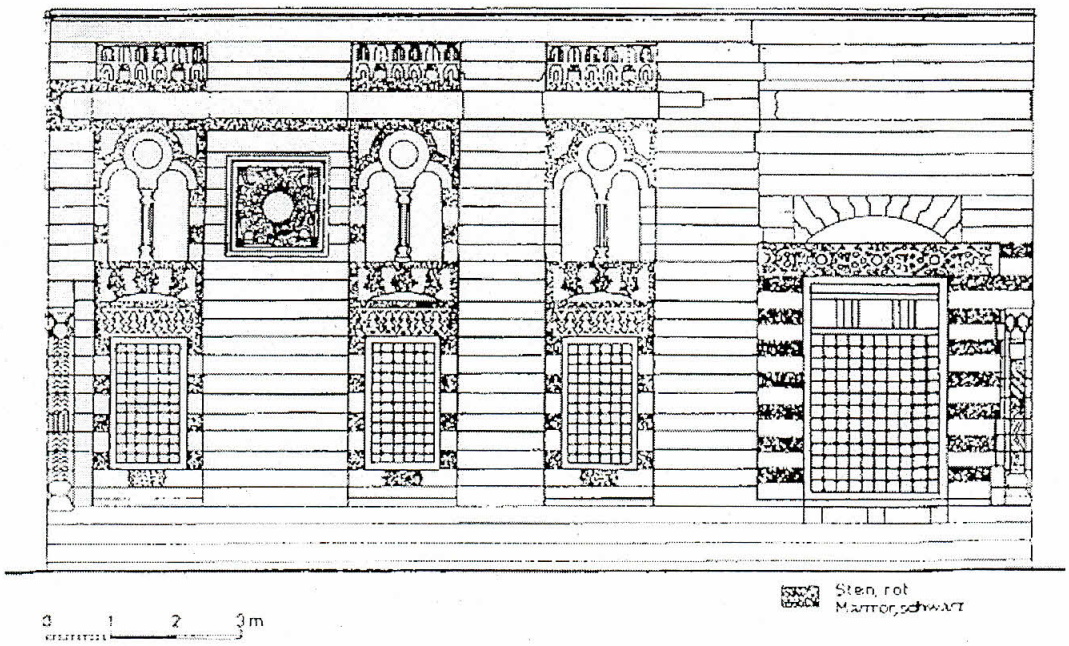


Fig. 11: East Facade

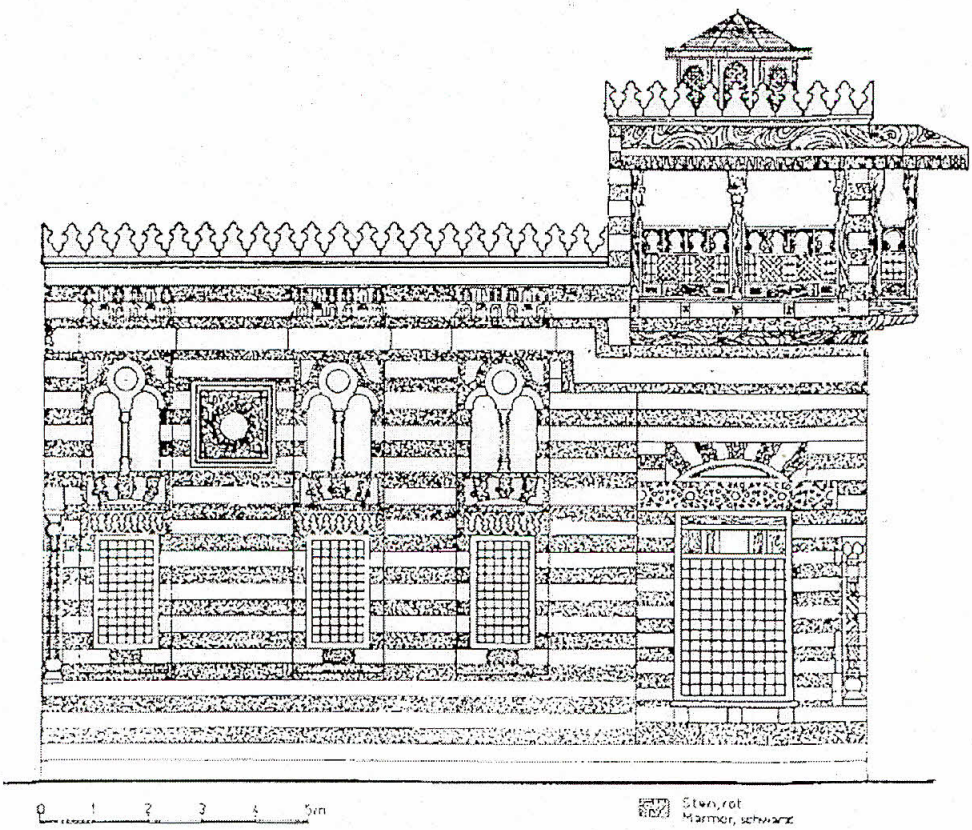


Fig. 12: East Façade – Reconstruction.

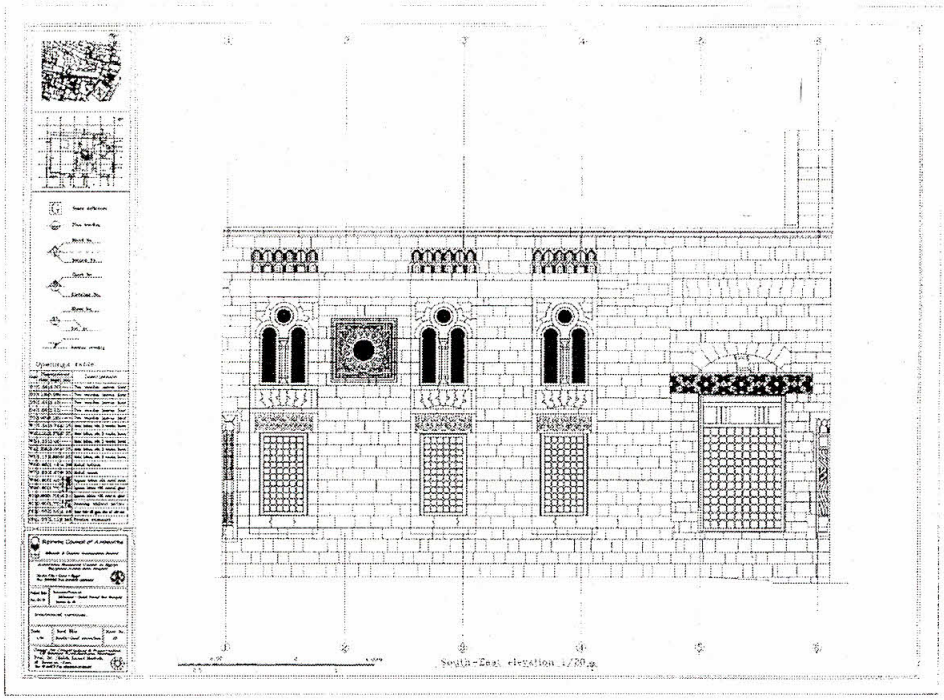


Fig. 13: South east Elevation.

Documentation & Recording

Historical, archaeological study:

Historical & archaeological recording was prepared through sources, manuscripts and historical documents in order to identify the architectural elements during the different historical periods till now (Figs. 6,9,13-16).

Photographic recording for the current situation:

It comprises a comprehensive photographic recording of the building's architectural elements to show the current building situation, the different details and decorations, as well as the different deterioration. The numbers, places and directions of the photographs have been recorded on the building plan or on the site general layout. The basic information concerning each photograph as well as the existing deterioration will be added for reference during the later conservation operations.

Surveying record

The surveying record was carried out by using modern surveying equipments to give the accurate architectural dimensions on plans, elevations, sections, details in order to help preparing the project's working drawings. This was accomplished by:

- Recording by using "Total station".
- Recording by using photogrammetry and rectified photography.
- Recording by using the theodolite & other different measurement equipment.

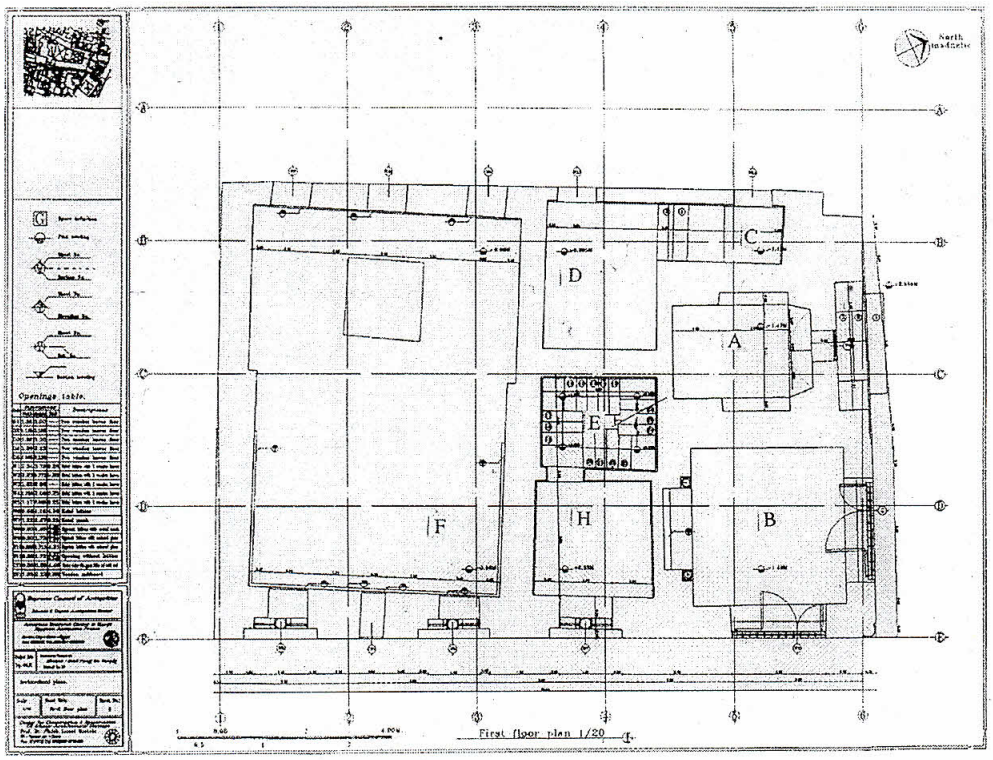


Fig. 14: First floor plan.

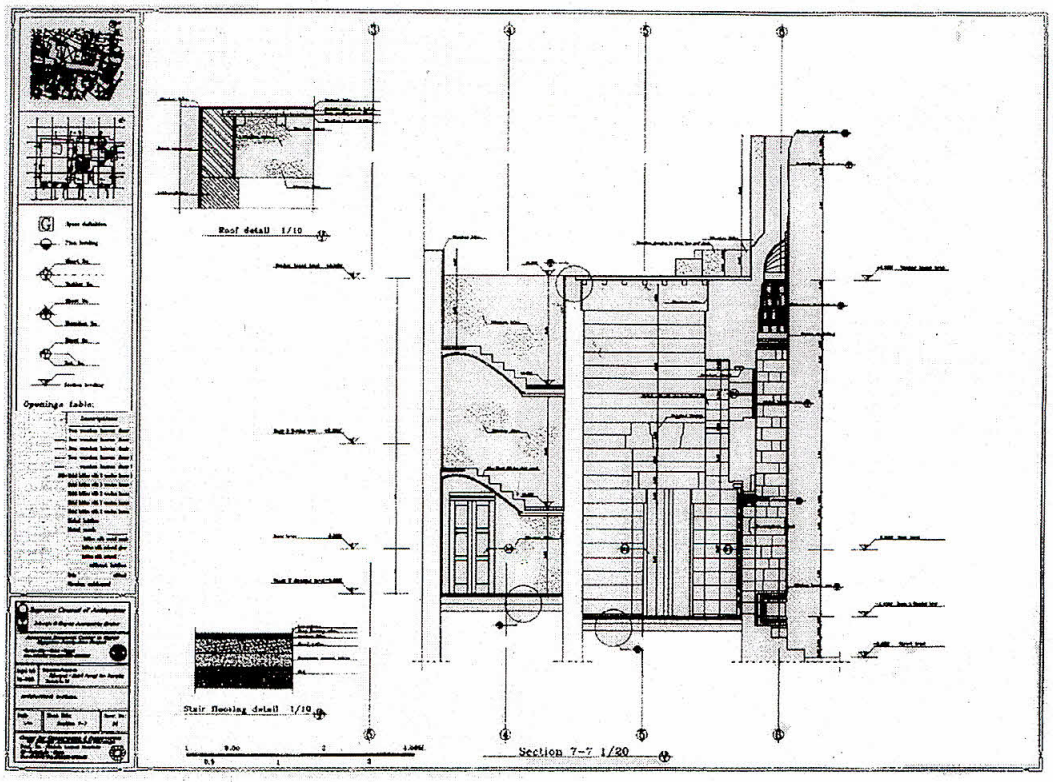


Fig. 15: Section 7-7.

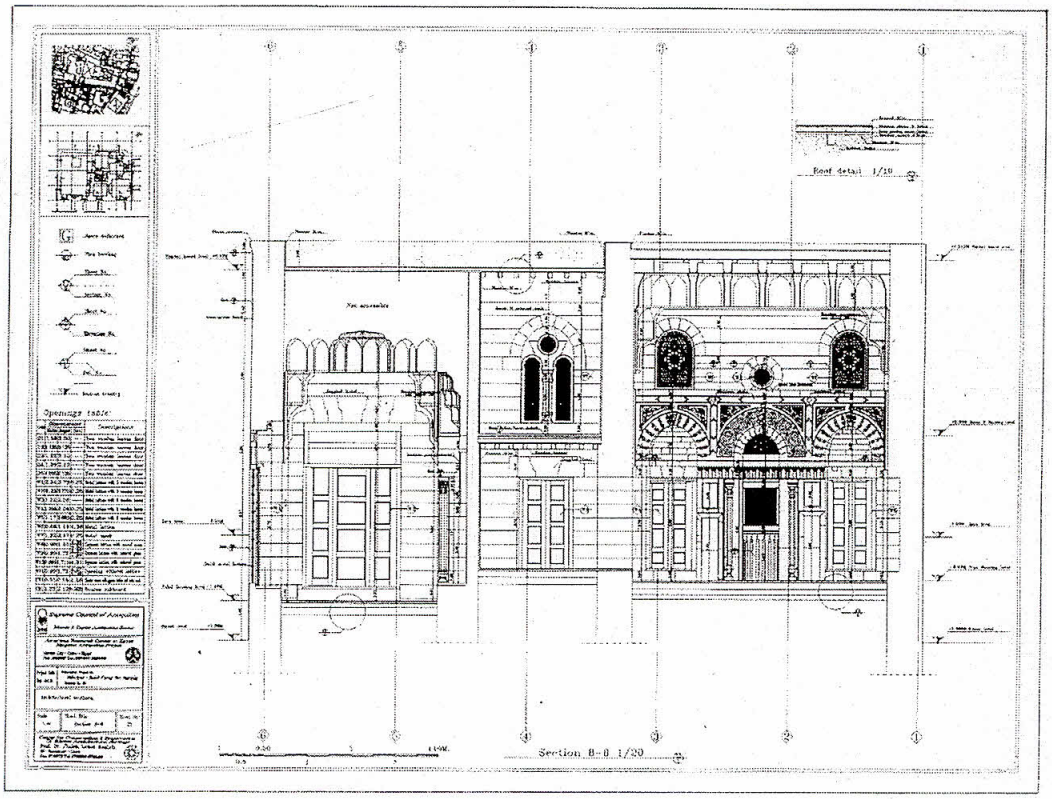


Fig. 16: Section 8-8.

Architectural recording:

As a result of the photographic recording and site surveying, the most necessary detailed building's architectural drawings have been prepared.

Scientific Studies & Assessment of Building conditions

Environmental studies:

Measurements of space temperature, wall surface temperature, relative humidity, dampness in walls, presence of electrically conductive salts and site chemical analysis of salts deposited on walls and on floor had been carried out. The measurements show that:

- The relative humidity is relatively high in the Sabil. This can be attributed to bad ventilation.
- Dampness was detected on the surface of walls in praying hall shows a high degree of dampness which has been a significant factor in the deterioration of the lime stone masonry (Figs. 17 & 18).

Lab. Analysis of building materials:

Stone and mortar samples were tested to determine their mineralogical composition and chemical analysis by [X-ray diffraction analysis, petrographic thin section. X-ray analysis of clay fraction, SEM (scanning electron microscope) as well as examination with Polarized Light Microscope] (Fig. 19).

The mineralogical and chemical properties of the painting material have been determined by relevant, reliable methods including x-ray diffraction analysis, microscopic examination of thin sections with transmitted polarized light and by some microtechnical analytical method.

XRD, SEM, FTIR spectra and optical microscope tested paste & Plaster samples to determine the nature of the organic resinous material present.

The previous laboratory diagnostic shows:

For the Stone samples

The main mineral forming the stone is calcite and the accessory mineral is quartz. By separating the clay fraction and testing it by X-ray diffraction it is found that Kaolinite is the main mineral composing the clay fraction, (Fig. 20).

For the Mortar samples

Analysis of the x-ray diffraction pattern revealed that the main mineral forming the mortar sample are Calcite ($CaCo_3$), Gypsum ($CaSo_4$, 2 H_2O) , and Quartz (SiO_2).

For the Paints and Plaster samples

The colored paints are natural mineral pigments of the OCHE type composed of Limonite

(The Bio-Rad FTIR spectra for the paste shows that the it contains salts of secondary or tertiary amines. Fe_2O_3), Goethite (Fe_2O_3. (n) H_2O). The paste is mainly composed by Gypsum ($CaSo_4$; 2 H_2O).

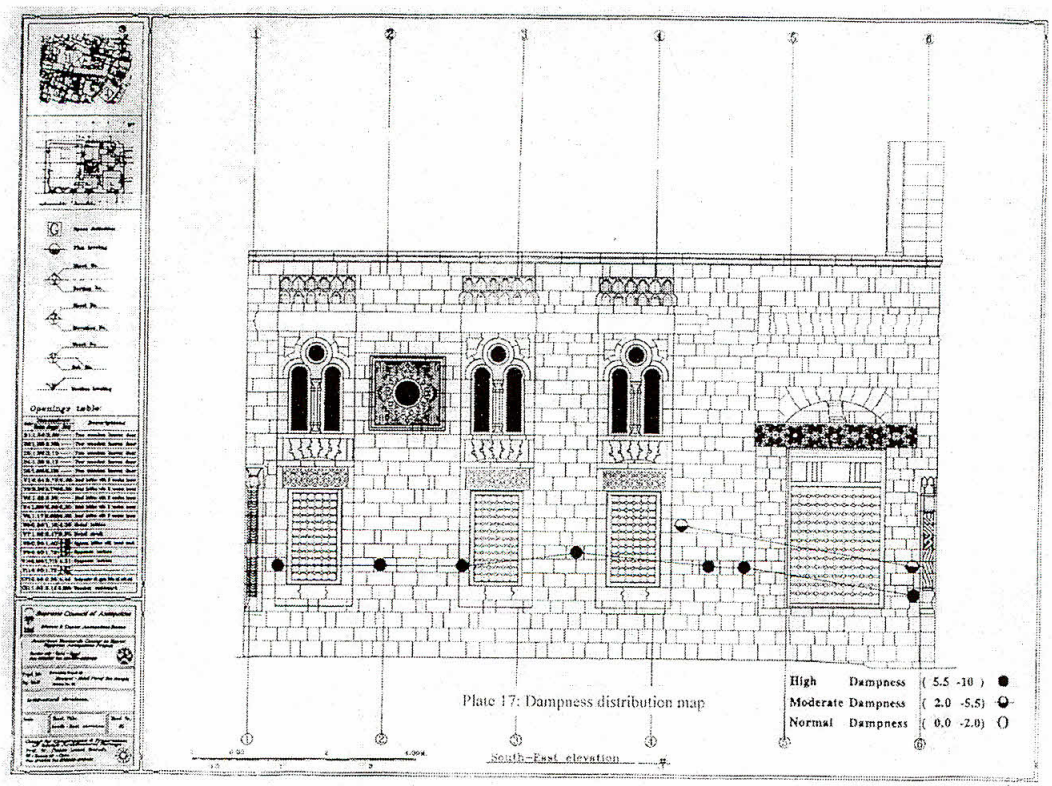


Fig. 17: Dampness distribution map.

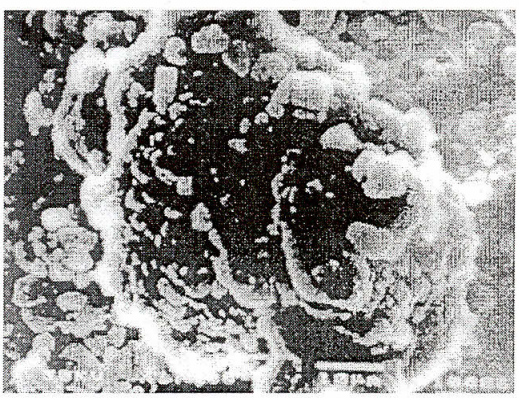


Fig. 18: Measuring dampness in walls.

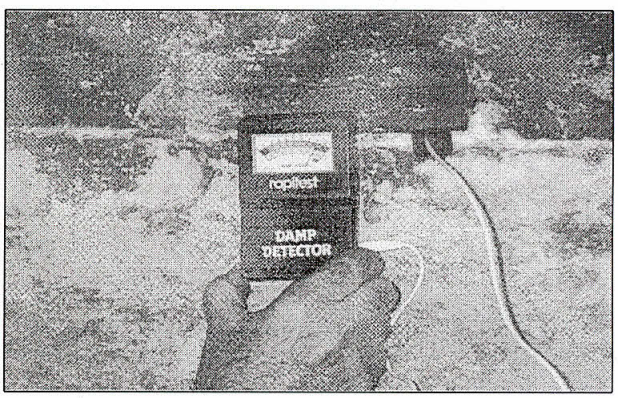


Fig. 19: Microscopic photo by SEM, showing the crystal structure of stone sample.

Soil & Foundation Investigation

Two bore holes carried at the site were executed using manual boring by auger, as well as four open pits inside the building. The laboratory tests and the analysis of soil parameters shows (Fig. 21):

The soil formation at the site is dominated with the fill (manmade) layers, which exists in the area of old Cairo. The old formed filling layer contains silty clay formation with boulders, cobbles and broken limestone in different sizes and different percentages.

The field investigation showed that strip footings of foundation element made of red brick and random stones (Figs.22 & 23).

Chemical analysis of ground water sample was performed in order to determine the sulfate and chloride contents as well as the p H value. The analysis shows that Sulphur trioxide SO_3, as part per million or milligram per litre, was 1235; salinity as Sodium Chloride NaCl 879 which exceeds the allowable ratio.

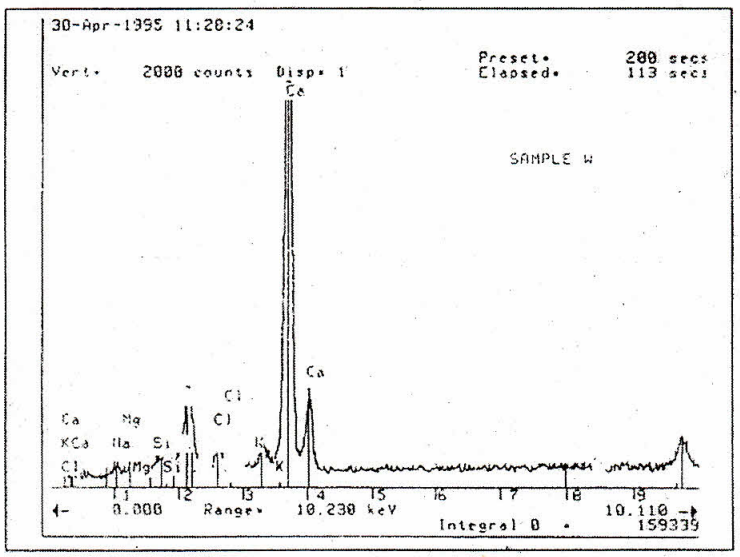


Fig. 20: Microanalysis of the X-ray resulted from the scanning of a limestone sample.

Recommendations:

Sulfate resisting portland cement should be used in case of repairing the foundation elements. It is also recommended that cement amount should be not less than 400 kg/m^3 of produced concrete on using 10 mm nominal aggregate size. The maximum water cement ratio (W/C) is 0.50. Due to the relatively low Ph value in addition to the mentioned SO_3 value, it is recommended to use adequate protective coating (insulation) to the existing and new foundation elements.

In case of dewatering it is recommended to excavate trenches around the foundation and used surface dewatering with slow rate pumps.

Structure & Stability Studies:

The building is a wall bearing structure, with lime stone and brick walls. It has a wooden roof made of timber boards supported over main wooden beams. The screed layer over the roof are severely deteriorated allowing the rain water to infiltrate the roof and causing severe damage to the wooden elements of the roof.

The structure and stability studies highlights the state of the stress at various elements and to identify the locations of stress concentration, a stress analysis to the monument was conducted, it includes:

1. Examining the stresses in the roof elements.
2. Examining the stability and the stresses of the cantilever wall above the monument's entrance.
3. Examining the state of the stresses in the bearing walls.

The seismic force analysis show that the maximum tensile stress expected is 3.6 kg/cm^2, which is exceeding the allowable limit by 3 %.

Based on the stress analysis results, it seems that there is no need for retrofitting or strengthening the walls by addition of a new structural system.

Conclusions & Recommendations:

It is recommended that the roof dead load should be kept less than 500 Kg/m2 and the wooden main beams should be replaced with new bigger beams having 10 x 12-cm cross section arranged at 40-cm spacing.

The stresses in the monument under the action of the dead loads are within the allowable stresses (Figs. 24-28).

Based on the visual examining of the building and the results of the conducted analysis, the following can be concluded:

1. The roofing material, the rubble stone and brick layer and screed should be replaced with another protective roofing system to prevent infiltration of rain water through the roof in the future.
2. The disintegrated stones in the western and southern walls to be replaced and the western brick wall to be rebuilt.
3. The main wooden beams should be replaced with new beams.
4. Minor cracks observed close to wall corner connections and around openings should be patched up with the use of plastic mesh.

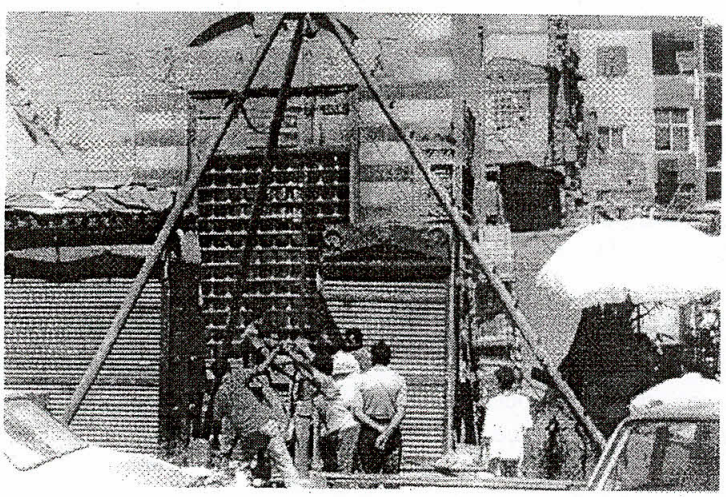


Fig. 21: Making boreholes at the site.

Conservation Strategy:

This project is done in respect with the charters at **UNESCO**:

- Venice Charter 1964.
- Lahore Recommendations 1980
- Authenticity charter 1996.

As the Venice Charter is the basic reference until now for conservation at UNESCO, we have to mention here the following articles:

Article 6:

"The conservation of a monument implies preserving a setting which is not out of scale. Wherever the traditional setting exists, it must be kept. No new construction, demolition or modification which would alter the relations of mass and color must be allowed"

Article 10:

"Where traditional techniques prove inadequate, the consolidation of a monument can be achieved by the use of any modern technique for conservation and construction, the efficacy of which has been shown by scientific data and proved by experience".

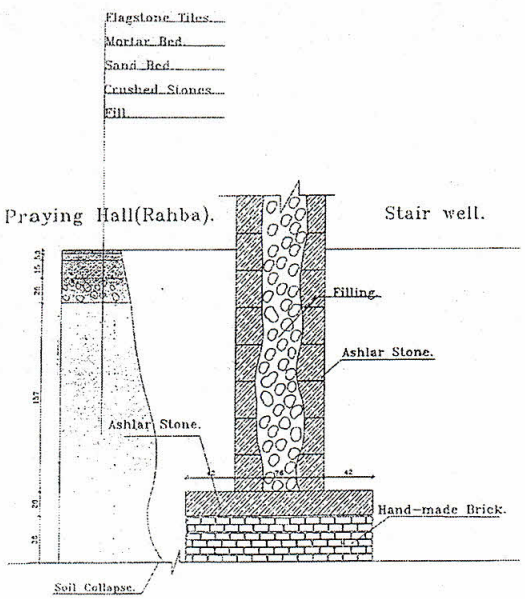


Fig. 22: Foundation section according to open pits no. (1).

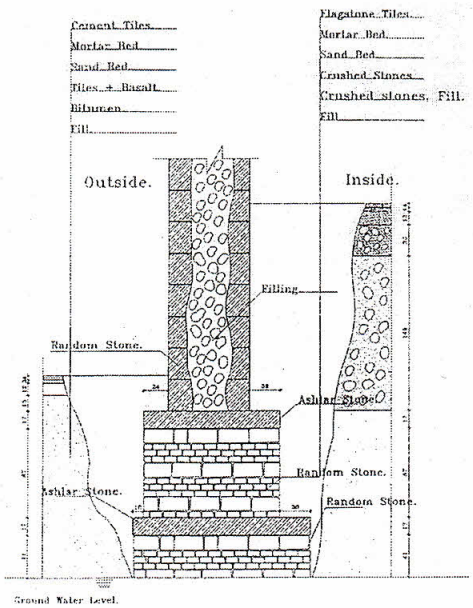


Fig. 23: Foundation section according to open pits no. (2)&(3).

Article 11:

"The valid contributions of all periods to the building of a monument must be respected, since unity of style is not the aim of a restoration. When a building includes the superimposed work of different periods, the revealing of the underlying state can only be justified in exceptional circumstances and when what is removed is of little interest and the material which is brought to light is of great historical, archaeological or aesthetic value, and its state of preservation good enough to justify the action. Evaluation of the importance of the elements involved and the decision as to what may destroyed cannot rest solely on the individual in charge of the work".

The following General Standards for Preservation & Conservation of this project are:

1. Every reasonable effort shall be made to provide a compatible use for a property that requires minimal alteration of the building structure, or site and its environment, or to use a property for its originally intended purpose.
2. The distinguishing original qualities or character of a building, structure, or site and its environment shall not be destroyed. The removal or alteration of any historic material or distinctive architectural features should be avoided when possible.
3. All buildings, structures, and sites shall be recognized as products of their own time. Alterations which have no historical basis and which sought to create an earlier appearance shall be discouraged.

4. Changes, which may have taken place in the course of time, are evidence of the history and development of a building, structure, or site and its environment. These changes may have acquired significance in their own right, and this significance shall be recognized and respected.
5. Distinctive stylistic features or examples of skilled craftsmanship which characterize a building, structure, or site, shall be treated with sensitivity.

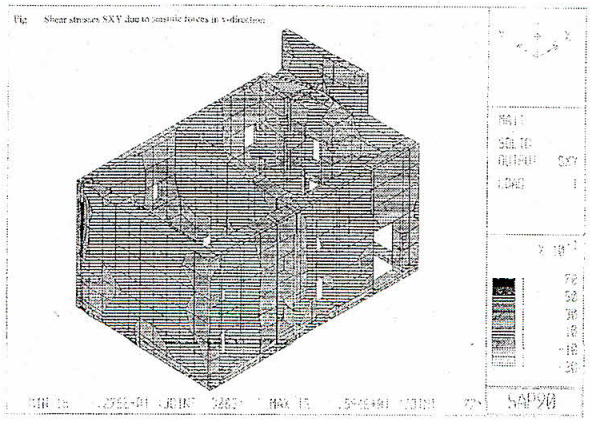


Fig. 24:

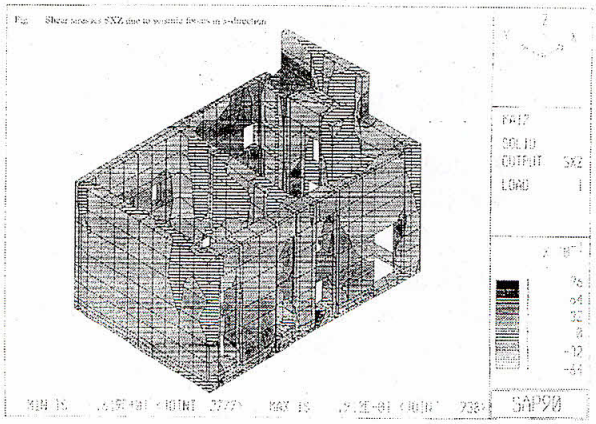


Fig. 25:

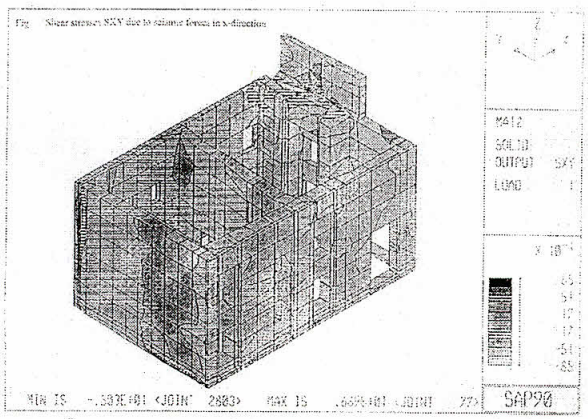


Fig. 26:

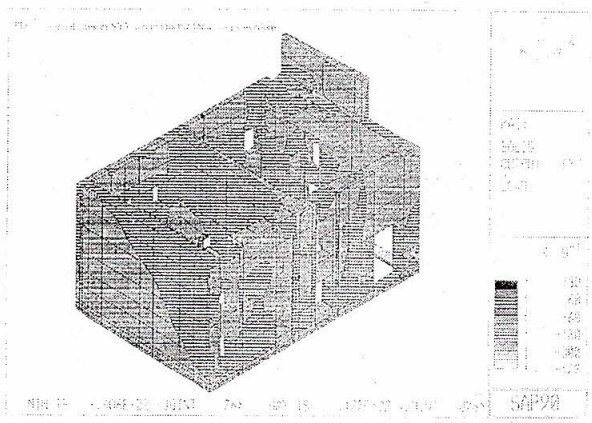


Fig. 27:

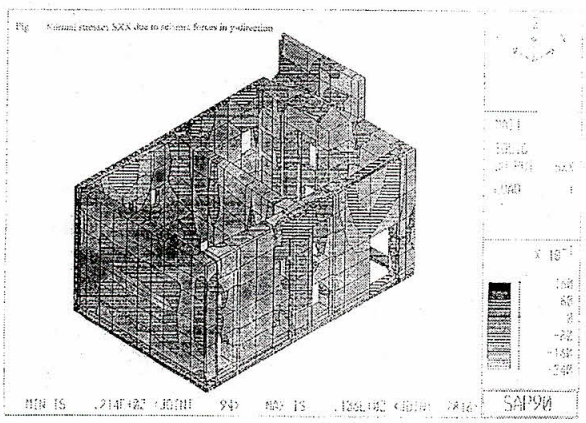


Fig. 28:

6. Deteriorated architectural features shall be repaired rather than replaced, wherever possible. In the event replacement is necessary, the new material should match the material being replaced in composition, design, color, texture, and other visual qualities. Repair or replacement of missing architectural features should be based on accurate duplications of features, substantiated by historical, physical, or pictorial evidence rather than on conjectural designs or the availability of different architectural elements from other buildings or structures.
7. The surface cleaning of structures shall be undertaken with the gentlest means possible. Sandblasting and other cleaning methods that will damage the historic building materials shall not be undertaken.
8. Every reasonable effort shall be made to protect and preserve archeological resources affected by, or adjacent to, any acquisition, protection, stabilization, preservation, rehabilitation, restoration, or reconstruction project.

Conservation plan had started after the completion of the required documentation as well as the architectural recording and preparing of working drawings, the regulations and specifications, the estimated bill of quantities, as well as the cost estimation. It includes technical recommendations for cleaning and consolidation works of the mosque according to the following items:

Walls & Polychrome stonework:

- The walls present in the monument are mainly of limestone courses.
- X-ray diffraction analysis and chemical analysis shows that the main constituents are Calcite ($CaCO_3$), Dolomite ($Mg\ CO_3$), with insoluble residue (Clay, Silt, Sand etc.). Walls suffer from rising damp and accumulation of dark crust. Rising damp was detected using Protimeter moisture meters revealing rising damp in the lower third of the walls.
- Salts analysis in situ using the Protimeter salt detection kit shows that nitrates and chlorides were present in all locations. Walls exhibit severe salt efflorescence to a great height.
- Salts was collected for chemical analysis showing that the main constituent is Halite (NaCl).
- Presence of shops at the east facade caused the decreasing of the rate of evaporation of humidity in walls.
- Presence of Gypsum crust, which analyzed by EDS shows the presence of Sulfur (Calcium and Magnesium sulfates) so cleaning must be performed slowly, by hand.

For The Limestone Walls:

- Several cleaning tests were performed in order to find the best method. The Triton X-100 solution was more effective in removing grime than clear water
- The stone at the east facade is covered with a dark crust. A clay poultice was Applied to the encrusted area of the stone.
- Restoration of random rubble stones in the lower part of the western facade.
- Gel was used in a series of poultice cleaning tests.
- Ethyl silicate – based consolident have been used with a neutral catalyst such as dibutyltin dilaurate, it is the most appropriate consolident for local consolidation

Interior Decorative Polychrome stonework

- The interior decorative polychrome stonework are mainly:
  a- White marble panels.
  b- White marble capitals, columns, borders, and mosaic inlay.

c- Red & black granite panels.
d- Red stone inlay (mainly Calcite, Dolomite, Quartz and Hydrated Iron Oxide).

- The surface element became (saccharoidal) due to sulfation & salt efflorescence. Intergranular boundaries have opened due to erosion of the Calcitic and Dolomitic components.
- White and black marble elements were cleaned from crusts, stains.
- Loose panels were reattached by replacing salt-laden mortar.
- Inlaid stone was replaced.Broken elements was replaced.

Paste inlay (black and red)

- The paste is used to create finer and delicate forms as well as infilling material to extend and close gaps in marble layer. It is generally composed of Calcite ($CaCO_3$), Quartz, and Gypsum.
- The paste is cracked, the edges eroded.
- The paste should be cleaned at the minimal level, aqueous cleaning may cause damage to degraded organic & inorganic materials, and water may activate the salts present.
- Deteriorated area of the pastes must be reinforced & reattached.
- Consolidation of the paste by introducing dilute acrylic resin and reattachment of loose fragments of paste.
- Reattachment of loose fragments of paste should be performed. An acrylic resin solution (Acryloid / Paraloid B72, an ethyl methacrylate copolymer in acetone).

Roofs and ceilings:

1. The ceiling is in bad condition (damage in both wooden support and the decorative surface) due to environmental effects –physical and biological agents such as:
   - Accumulation of dusts & smog, which are very thick on surfaces, the surface dirt become embedded, weakly bound paint, layers.
   - Infiltration of rain water into the walls causing cracking in the plaster.
   - Insect attack causing weakening of the wooden structure, as well as affecting the decorated surfaces.
   - Water soluble salts from mortars, gradually taken into solution in the water, have accretions on the surface causing the destroying of the paint layers .
   - Abrasion caused massives losses of paint.
   - The bonds between plaster layer have been affected by physical stresses causing internal layer delamination.
2. The structure will be stabilized, the decorative finishes will be consolidated and cleaned according to the laboratory recommendations as follows:

a- *Surface dirt*: was removed by brushing and light vacuuming
b- *Embedded dirt*: was removed by two systems:
Dry Cleaning: by mechanical actions such as abrasion, blowing, suction.
Wet cleaning:

- Aqueous: water based with alkaline additives such as Ammonia, detergents (anionic or cationic) to increase cleaning action.
- Non-aqueous: involve using organic solvents.
- Combined system (aqueous and non-aqueous system).

3. It was noticed that all surfaces are extremely sensitive to water, so direct washing with water was not possible and the best way was the dry cleaning or using a solution of resin in organic solvent.
4. As for the consolidation of the wood and the plaster layers injecting an adhesive behind the delaminating layer treated it.
   There are various methods of applying the consolident solution.

Carpentry works:

- The carpentry works include (doors, windows, cupboard or bookcase, turned woodwork).
- The carpentry works are in bad condition due to the rising damp problems. The doors have been repaired and modified several times in the past.
- The cupboard (bookcase) needs to be isolated from the stone walls, as well as reattaching of new hinges matching the architectural features of the old one.
- As for the doors and windows, the original one will remain taking in consideration to preserve, restore and complete the missing parts.
- For the exterior turned woodwork, it will be cleaned with turpentine + acetone in the ratio of 1:1and treated with a preservative.

Metal works:

1. Iron and copper grilles:

   The grilles in the sabil are copper alloys (bronze), while the grille to the left of the mihrab is iron.
   The grilles are in bad condition due to coating material (organic coating) and metallic corrosion.
   The grille will be cleaned with a dry brush, ferrous corrosion will be removed followed by applying an emulsion made with white spirit and water with drop of Triton X-100 non-ionic surfactant, then applying a wax coat for protection.

2. Copper panels:

   Copper panels on the entrance door are mainly brass sheets. Panels must be cleaned from grime and accretions, a protective coating will be applied on the surface.

3. Interior Iron hardware:

   Interior Iron hardware such as (hinges, hooks, iron mesh, ferrous metal lattice)
   Iron hardware must be cleaned, stabilized, ferrous metal lattice will be coated, using non-agressive, mechanical and chemical conservation techniques. Missing elements will be replicate.

Marble work:

- North & East Facade:

The marble blocks on the north and east facade is soiled with dust and mineral crusts.

A marble molding frames the front entrance and an inscription band flanks the front doorway.

Traces of red polychromy were found on the mortar surrounding the marble.

Cleaning of marble on the east, north wall and the mihrab by applying water spray, then using 1% Triton X-100 non –ionic surfactant applied with a damp swab.

Gel poultice based on methylcellulose was used after cleaning with Triton X-100 solution.

- The mihrab panels:

Loose panels will be reattached, Replacing missing elements, repairing broken element. Preserving old overpaint, consolidation of loose paste inlay.

Consolidation of mihrab panels using Acryloid B72 in acetone.

Electrical works:

Old electrical network will be replaced. A new one has been designed, so that it should not disfigure the inner space. Lighting elements such as: glass lamps "mishkawat", wall bracket unit & lantern, flood light units will be installed.A bronze & wooden chandelier for the prayers Hall as well as a wooden wooden chandelier for Sabil will be manufactured and according to the historical feature of the building details.

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مشروع ترميم وصيانة مسجد السلطان فرج بن برقوق:
أثر رقم ٢٠٣ (العصر المملوكي الجركسي)

صالح لمعي مصطفى

القاهرة ، جمهورية مصر العربية

ملخص البحث: يتناول هذا البحث الأسلوب المنهجي العلمي الذي اتبع في مشروع ترميم مسجد فرج بن برقوق (١٣٨٢-١٥١٧م) والذي يتميز بناؤه بالزخارف ومواد الإنشاء الثمينة. ويوضح البحث كيفية وضع الدراسة التاريخية الأثرية المعمارية حيث يتم جمع البيانات الخاصة بالموقع والمنشأة وكذلك تحليل عناصر المبنى من الناحية الوظيفية والهندسية ومن ثم إعداد دراسات الاتزان والوضع الإنشائي للمبنى وعناصره و ذلك بتحديد أسباب تدهور المنشأة من حيث طبيعة التربة الكيميائية والفيزيائية والميكانيكية، إضافة إلى دراسة المياه الأرضية وخصائصها واستخلاص مدى تحمل المبنى للأحمال المؤثرة عليه ودرجة احتياجه إلى تقوية أساساته وحوائطه والأساليب المتعددة لمعالجتها. ثم يتطرق البحث إلى مواد البناء المستخدمة و خواصها النوعية والهندسية والفيزيائية والميكانيكية. وتستعرض الدراسة في الختام الطريقة المثلى في صيانة وترميم هذا الأثر المعماري استنادا" إلى البيانات المجمعة.