YEMEN ARAB REPUBLIC

Emergency rescue of cultural property

Visual Inspection of the Al-Ashrafiyah Mosque

by
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YEMEN ARAB REPUBLIC

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THE AL-ASHRAFIYAH MOSQUE

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Alejandro Alva

Report prepared for the Government
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1. At the request of the Government of the Yemen Arab Republic, the Director-General of Unesco arranged, under the Organization's Regular Programme for 1979-1980, for a mission to be carried out in that country from 8 to 14 April 1980, by Mr Eugenio Galdieri, architect, ICCROM consultant, and by Mr Alejandro Alva, architect, Assistant Co-ordinator of the Architectural Conservation Course, ICCROM.

2. The mission's terms of reference were: "to put at the disposal of the Yemen Arab Republic, Unesco's technical assistance to analyse the structural weaknesses in the Ashrafiyah Mosque, Taiz (Yemen Arab Republic) and to design a structure to reinforce the building and plan its restoration".

3. Previous references mentioned the request of immediate intervention of an inspection team to assess the critical condition and/or the risk of collapse of the Ashrafiyah Mosque in Taiz.

4. Thanks are due to all those who facilitated arrangements and provided skilful assistance and guidance throughout the mission, and especially the following persons:

   Qadi Ismail Al-Akwa, Director of Antiquities of the Yemen Arab Republic;
   Qadi Seman, Minister of the Awqaf;
   Hamond Ahmed Al-Medwahi, Vice-Minister of the Awqaf;
   Abdullah Makafi, Director of the Taiz Museum;
   Ahmed Mohammed Sana'ani, Co-ordinator and administrator of the Ministry of Awqaf;
   Rosalind Wade, Archaeologist, Adviser of the National Museum, Sana'a.

5. A special tribute is due to the Governor and to the Deputy Governor of Taiz, Mr Abdul Karim Adullillah, for their interest in the conservation of the City of Taiz and their eagerness to co-operation with Unesco and ICCROM.

The building and its problems

General description and location

6. The al-Ashrafiyah Mosque stands on the steep slope of the granite hillside of Mount Saber.

7. The building extends over a total area of more than 1,500 m². The roofing structures cover about 1,200 m² of the total surface.

8. The main north-south axis of the mosque divides the building into two almost symmetrical parts, whose northern sides form the back wall of the fabric. Since Yemen is south from Mecca, the back or gibaln wall of the mosque faces north. As the main axis coincides with the profile of maximum slope, the gibaln wall is also that part of the structure that faces the valley at the bottom of the slope (Figure 1 and section).
9. From an architectural standpoint, the building consists of: an oblong prayer hall, covered by a central dome flanked by two groups of four small domes; two barrel-vaulted wings (east and west); two tall minarets with a square base (south-east and south-west corners); and a fabric block joining both minarets along the southern side of the mosque, covered by two barrel vaults on the right and left sides of a central dome.

10. The external dimensions of this first part of the complex are approximately 26 m x 27 m; it encloses a courtyard of about 10 m x 11 m. The surface of the courtyard is partially covered by three funerary pavilions, each sheltered by a small dome.

11. An ambulatory surrounds the east, south and west sides of this part. Two small domes cover the north-west and north-east ends of the ambulatory. The rest is completely uncovered and its southern side is formed by an oblong structure measuring about 35 m x 5.5 m. This building is covered by a central dome, two domes (one on the west end and one on the east end) and two barrel vaults flanking the central dome.

12. At the west, south and east sides of the ambulatory there are three tall entrance porches. From both the architectural and engineering standpoint, the southern porch is the more interesting.

13. With the exception of the giblah wall (northern façade), the other elevations of the building have no features of particular interest. The giblah wall is crowned by three superposed orders of blind arcades forming an overall ornamental element that evokes the plastic effect of the mugarnas. Nevertheless, the dominant element of this façade is the slender structure that seems to emphasize the axial location of the mihrab.

14. The whole prayer hall is supported by the structures of a fabric which is partially underground. This fabric consists of nine masonry walls perpendicular to the north façade and a long corridor covered by a barrel vault and parallel to the giblah wall.

15. Inside the prayer hall the first impression is created by a rich - almost too rich - decoration in white stucco. Various ornamental features of different styles cover the surface of walls, arches, shell-shaped elements, blind niches, door plaster casings, etc. Below all, a superb epigraphic fascia emphasizes the extrados of the arches and divides the wall surfaces in two at a height of about 1.75 m.

16. A second characteristic decorative feature in the prayer hall is that of the wall paintings. Covering all the wall surfaces, from about 6 m above ground level up to the apex of the central dome, at about 13.20 m. They do not display a completely harmonious blend of geometric, floral and epigraphic decorative features. Despite their inventiveness and skilful execution, the wall paintings somehow "cast a shadow" over, rather than enhance, the spatial and plastic values of the mosque's interior architecture. It should be noted that the epigraphic elements have been painted with extreme accuracy and with larger features than all the rest. From just over 6 m. above ground level, up to the height of the epigraphic fascia, the wall paintings have been covered with a uniform whitewash of gypsum, or else replaced by a heavy decoration of white stucco. Samples of surface layers will need to be taken in order to verify what seems to be the superposition of three separate decorative phases, from different periods.
17. A third characteristic of the prayer hall is constituted by the two piers that support the central dome and limit the central space of the hall, and by two secondary pillars that subdivide, at each side of the central space, four dome-covered minor spaces. The section of these four piers (Figure 2) generates surfaces that create an interesting delicate effect of light and shade.

18. A different aesthetic effect is created by the three funerary pavilions in the courtyard. These structures, covered by domes with bean-shaped ornaments, all seem to follow a contemporary technique and style in building and decoration. Features of particular interest can be seen in the six multi-foil arches that crown the entrances to the funerary pavilions. Unfortunately, most of the gypsum panel-screens of the tympanum have been destroyed and only a fragment of one of these still remains in situ as a testimony of the richness, fantasy and skilled work of this decoration.

19. Other elements worth mentioning are the elegant proportions of the twin (not identical) minarets (Figure 3); the moderate style of the central dome, characterized, at its base, by a ring of notched architectural elements (Figure 4); the decoration of the wall surfaces in the courtyard, consisting of three different orders of blind arches and niches, imitating the decoration of the north façade. This wall decoration was seriously damaged to begin with by the construction of the three funerary pavilions, and more recently, as a result of the arbitrary repair works done with Portland cement.

20. The portals and other details will be discussed later.

21. Lastly, some reference should be made to the hall of ablutions in the south-east corner of the complex. No structural problems were identified during the inspection. Nevertheless, regular maintenance work should be carried out in the whole area after implementation of the general proposals set out in this report.

Structural condition of the complex

22. As mentioned in the previous section, it was not possible to assess or determine the incidence or extent of defects in the building's foundations. Nevertheless, even with this restriction, we believe that the general structural conditions of the building can be described as satisfactory. None of the numerous cracks identified seem to indicate a particularly serious static problem. Furthermore, within the limitations of a visual examination, none of the cracks show evidence of major ongoing movements that could affect the main structural elements of the building and, in particular, the two minarets and the central dome. Broadly speaking, we can rule out abnormal structure settlements (bearing in mind the type and age of the building system); structural subsidence of load-bearing elements (foundations, levelling members, piers, etc.); crushing by over-loading; or, skidding movements of the structural members in contact with the rock bed. A priori, the possibility of skidding movements in the bedding foundations or of the bedrock, caused by poor anchorage, or by the action of rain or deep water, would have been the worst possible eventuality. But in this case salvaging the mosque would have been possible, though it would have called for arduous hydrogeologic investigations and expensive soil stabilization works. Considering the building as a whole, the mosque seems to be well-consolidated in its foundation soil.
23. However, the problems posed by existing humidity cannot be neglected and as Mr William H. Cary points out in his 1979 report "the surface water coming from the mountain behind should be channelled away from the south and east walls". Some of the channelling or water conveyance works have been recently completed along with the uphill retaining wall. Related works which are still in progress will certainly contribute to reducing the problems caused by dispersed water.

24. In order to evaluate and determine the incidence, extent and implications of the action of water in the structural members of the building, numerous readings were taken with a protimeter. As a result of this humidity survey three extremely important facts emerged: (a) in general, the recently repaired external system of drains and the internal drainage of the mosque (probably the original) both work adequately; (b) the moisture content in load-bearing elements is fairly low and localized in areas that permit rain-water stagnation; (c) Portland cement coatings applied to wall surfaces worsen the dampness problem. The walls on which this coating was applied had previously no real problems with damp. In practice the new cement coating did not have the desired practical effect but tended rather to heighten the level of water in the wall. This problem will be discussed in depth in paragraph 91.

25. The problem of roof waterproofing is quite different. Our examination showed that: (a) the sloping surface of the roof seems to be sufficient; but, because of subsidence of small areas of the roof's surface plane and limited cleaning of the whole area, rain-water stagnation occurs; (b) repairing of roof leaks has been poorly done: old repair works were done employing the appropriate traditional technique; however, shrinkage of the repair material resulted in a poor connection between the old coatings and the infill material. Unfortunately recent repair works have been done with Portland cement mortar. Apart, therefore, from the normal shrinkage of the material, complete detachment has occurred of the repair work from the original surface coating. In spite of the apparent soundness of the whole roof surface, rain-water can still penetrate deeply into the structural members underneath it.

26. In summary, dampness has not yet caused damage to the load-bearing structural elements. In any case, channelling dispersed rain-water away from the mosque should prevent this from happening. On the other hand, rain-water penetration through the roof surface has seriously damaged internal decorations (wall paintings and stucco) and continues to weaken the structure. Because of poor quality repair works local failure of structural members can add excessive loading to sound structures and in a short time this could result in a partial collapse of the building.

Structural condition of individual architectural elements

27. As previously mentioned, the whole complex consists of different buildings or fabric blocks; these, following the order of the description, are: the prayer hall, the courtyard with three funerary pavilions, the southern fabric block, two minarets, two lateral halls (east and west), the southern fabric block between the minarets, the ambulatory along the east and west sides, the two portal doorways, and, the hall of ablutions. It would be a serious mistake to consider each one of these architectural components as an unitarian, single, massive or monolithic structure. In this connection we disagree with Mr Cary's statement that "the mosque is a massive wall brick masonry structure". This is not the case, not only because the whole complex is a typical example of mixed or combined structures (in which brick masonry
has been used only for the vaulted structures - those of the fabric emerging from the central part of the north wall, and, the middle and upper fabrics of the minarets), but, above all, because the particular building system makes almost independent the behaviour of each individual structure, rather than each architectural unit. What seems at first glance to be a monolithic building, consisting of a central hall flanked by two groups of secondary halls, turns out, in fact, to be a complex of nine partially interdependent individual structures placed side by side. Furthermore, in considering this particular building system - so different from known Western methods - it is also necessary to take into account the contrasting static behaviour of two building materials: stone masonry in the lower fabrics, and brick masonry in the upper fabrics (generally in a thrusting action). As a result, one can appreciate how dangerous it would be to misunderstand completely the diagnosis of the general, and particular crack or fault patterns on the building.

28. Having clarified this aspect which we believe is fundamental for an exact evaluation of the static condition of the mosque, we will now examine the structural condition of individual architectural elements.

29. The following site notes record structural faults identified as a result of visual inspection, working clockwise from the north-west corner, and from top to bottom:

**Roof**

30. Two staircases lead up to the main roof level, both of which are inside the structures of the minarets. The main roof structure consists of two portico domes at the north-west and north-east corners of the ambulatory, two groups of four small domes flanking the central dome on the west and east sides, a central dome, a small dome characterizing the qiblah structure, two barrel vaults (west and east halls), three bean-shaped decorated domes covering the funerary pavilions, a small dome flanked by two barrel vaults covering the halls between the minarets (south side). The remaining roofs are those of the doorways (domes), two small domes on top of the minarets, and small vaults and domes over the ablution area and the south fabric (school). The roof is completely in plastered brick, except for recent additions in Portland cement. A battlement parapet runs on top of the perimeter walls, enclosing the roof's main structure.

31. **NW portico corner**

   Cracks from the apex to the ring of the portico's dome.

   Crenellation edges are damaged or broken.

   The roof's slope should be checked to prevent stagnation of rain-water on the plane surfaces.

32. **NW domes (NW1, NW2, NW3, NW4)**

   All four domes show a crack pattern consisting in an upper "circular" crack connected with cracks that come down to the base ring. Some of these cracks continue over the plane surface of the roof between each dome and over the lower arches. All cracks appear over the plastered surface and show repair work done with either Portland cement or the traditional technique and material. In both cases, cracking due to shrinkage has reappeared.
The roof angle of this area should be checked to prevent stagnation of rain-water.

Plaster rubbish should be removed.

33. Central dome

There is no evidence of structural faults on the whole external surface of the main dome.

Evidence of red, green and pink pigments can be found under the white-wash layer on the surface of the dome's drum on the alternating panel decoration.

34. Qiblah canopy

All structural elements of this architectural feature appear to be in good condition.

Crack tangential to the dome's ring, parallel to the north wall in the joint of the roof's plane surface and between the central dome and the qiblah canopy.

Electric wiring runs along the north wall behind the battlements. This should be removed and conveniently rearranged.

35. NE domes (NE1, NE2, NE3, NE4)

Surface cracking on all four domes in line with the patterns observed for the NW domes. Some of these cracks join on the plane roof surface at the centre of the four domes and on top of the NE pier of the prayer hall. Most of the cracks show Portland cement patching.

The plane roof surface should be cleaned and the sloping and run-off of rain-water checked.

Stagnant water can easily penetrate through cracks and patches.

36. NE portico corner

Broken and damaged crenellations.

Cracks appear on the dome's surface coming down to the joint of the plane surface at the base of the portico's dome and the east wall. Check for a tangential crack to the ring of the dome.

Prickly pear plants should be removed.

37. East vault

Surface cracking mainly transversely to the length of the vault.

The run-off of rain-water from north to the the SE corner should be checked.

Damaged east wall crenellations should be repaired.
38. **SE minaret**

The structure, as a whole, appears in good structural condition.

One of the three wooden ties of the upper dome should be replaced. The other two ties should be checked and evidence of missing ones should be investigated.

Wooden course ties forming rings show signs of insect attack. However all appear structurally sound, except for the top one which is seriously damaged. In every case replacements should be made, if possible, with the same type of wood and with the same structural system.

The interior face of brick masonry only needs simple cleaning and partial repair and repointing.

Replace missing wooden steps.

All the interior needs regular cleaning and the bottom door should be opened to permit circulation of air.

Future work on the exterior should be limited to simple repair of crenellations, partial replaster, and whitewash. No plasterwork should be removed. The latter directive holds good also for the interior faces of the SE minaret.

39. **South fabric roofing (S1, S2, S3)**

S1 vault shows no evidence of structural faults.

S2 dome reveals surface cracking in a pattern similar to that mentioned for the two groups of four domes flanking the central dome.

S3 vault shows a surface longitudinal crack situated near the apex of the vault.

40. **SW minaret**

The whole is structurally sound and in good condition.

Wooden structural members show evidence of insect attack. If future work is to be done, all members should be checked and, in line with recommendations given for the SE minaret, replaced if necessary. Missing ties should be investigated (top dome) and replaced.

The interior should be cleaned regularly.

On the exterior, only partial replastering, simple repair works on cornices and crenellations, and whitewash, are desirable.

On both minarets, the balcony drainage system should be checked.

41. **West vault**

Surface cracking follows the same pattern as that described in the case of the east vault, but the structure as a whole appears less affected by it.
The west wall crenellations along the flank of the vault are partially damaged or show broken edges.

The plane roof surface around the vault should be checked to verify that the run-off for rain-water is adequate.

42. Central courtyard roofing (C1, C2, C3)

All the crenellations forming the parapet facing the courtyard need to be repaired.

Serious, and irreparable damage has been caused to these structures by the use of Portland cement in recent repair work.

An extremely delicate and costly intervention will be necessary in this part of the mosque to save the remains.

Portland cement work on dome C3, the construction of a flat reinforced concrete slab, the addition of reinforced concrete pieces to masonry supports, and the rendering of stucco decorations with Portland cement have all contributed to the aforementioned damage.

Ground floor level

43. NW corner (portico)

Crack near the apex of the pointed north arch of the portico.

Straightforward minor replastering should be carried out on the wall surfaces.

44. North wall

All of the original window frames have been removed.

Upper level windows are characterized by the recent addition of reinforced concrete lintels as opposed to the original wooden ones.

The lower level windows have new outer wooden lintels; the inner pieces were not replaced, but they show evidence of insect attack.

Partial detachment of plasterwork has exposed masonry, wooden courses and lintels.

Portland cement work has recently been done around the windows.

The depth and condition of the north wall foundations should be checked.

The original level of the street on the north side of the mosque should be investigated.

Rain-water run-off on the north street should be checked.

45. Qiblah structure

Monitor vertical crack on the qiblah structure.
Partial detachment of plaster has exposed the masonry.

The lower level has been worked on with Portland cement.

There is a need to investigate and document the original carpentry in order to consider removal of the recently installed metal doors.

46. **NE corner (portico)**

Cracking of the north side pointed arch (upper part) should be monitored.

47. **East wall**

The plaster coating is weathered and partially damaged by Portland cement rendering.

The sills of the ambulatory's arches have been damaged.

The street along the east side of the mosque has been paved with Portland cement in an effort to protect this side from rain-water running downhill. However, the run-off of rain-water should be still further investigated.

48. **East doorway portico**

Previous advice (W.H. Cary) recommended temporary buttressing the lower parts of the north and south walls of the portico. Unfortunately, the works done have the character of a permanent intervention but do not act against the bulging on top of the dome's supports.

Check for possible re-use of wooden structural members of the base of the portico's dome.

A new arch was built, within the last six months, on the east side of the portico.

49. **Inner east wall**

Check for colour pigment layers identified on the crenellations.

Diagonal crack below the SE of the prayer hall should be monitored.

Two of the five openings on this wall have suffered from the removal of the wooden lintels (ties) at the level of the springing line of the arches. These were replaced by reinforced concrete lintels. Fortunately, the original detailing that should serve as a model for future work can still be found in the three remaining openings.

The original carpentry also needs to be investigated in the case of the doors on this front. Removal of the metal doors should also be considered.

Check the growth of plants on the SE end.

50. **Ablution area**

The structures in this area have no significant faults.
The water supply for the area is connected with or derives from, the drainage system which comes from the gutter on the SE end of the east wall. Due to alterations of the channels on top of the walls the system does not perform its original function. The reasons for this should be investigated and the possibility of re-use of the whole system considered.

The top of the walls around the cistern has been raised and cemented.

The north side of the lintel on top of the door to the inner ablution area on the east wall shows a concrete addition.

51. Inner south wall

Black stain coming from the gutters on the wall of the minaret should be checked.

The bottom of the entire south wall has been worked on with Portland cement. This has increased the problem of dampness. Several measurements were taken with a protrimeter and all of the readings made confirmed this problem.

The wooden lintel above the door to the SE minaret has been attacked by insects. However, it appears to be structurally sound.

Crack on a stone lintel above the same door is not structurally significant. The inscription on this lintel should be recorded and investigated.

References on all drains underneath the existing pavement of the ambulatory along the south wall should be investigated and checked.

Crack on the stone lintel above the door to the SW minaret.

52. North wall of outer south fabric as seen from south ambulatory

The barrel vaulting along the length of this fabric has been demolished. The run-off of rain-water on the existing roof should be checked and the possibility of reconstructing the vaulting considered.

Check with plumb lines the east end of this wall.

53. Inner west wall

Consider removal of the door blockings to the west vaulted room.

As in the case of the east section, metal doors to the prayer hall have been installed in place of the original carpentry.

The drains of the west ambulatory should be investigated.

54. NW corner (portico) inner section

The inside surface of the dome shows signs of water penetration.

Cracks on the north, east and west arches of this structure should be monitored.
55. **West doorway portico**

The dome above this portico appears to be in good structural condition. Check wooden structural members.

The steps up to the portico have been covered with Portland cement. Maintenance, levelling and proper use of the wooden door of this gate could save this magnificent piece of carpentry of the mosque.

56. **West wall**

The gutter from a drain on the west ambulatory is blocked. Unblocking of the gutter and proper channelling of rain-water in this point are necessary.

Check the depth and condition of the foundations of this wall, in particular, near the NW corner.

57. **Prayer hall**

Domes NW1, NW2, NW3 and NW4 show stains caused by humidity affecting the paintings on the surface.

Reinforced concrete beam frames have been inserted above the arches of all NW domes. This unfortunate addition caused the partial loss of wall paintings and weakened the masonry structure.

The squinches (sprandels or pendentives) of the NW domes show vertical cracks.

All NW side open pointed arches show cracks near the apex.

Plaster on wall surfaces in this section (NW) has been partially removed. Cement was applied on the bottom part of the walls during the period of our visit. These works were stopped following our recommendations.

Crack on the east arch of dome NW2 should be monitored.

Monitor crack on the west arch of dome NW3.

The central dome of the prayer hall does not show evidence of structural problems. However, the condition of all painted decorations should be evaluated by a surface conservationist.

Two significant vertical shear cracks on west and east piers supporting the central dome should be monitored. Both cracks start from the drum of the dome and are visible down to near the capital of each pier.

The painted surface of the drum shows evidence of humidity damage.

The canopy over the qiblah niche has been badly affected by insect attack.

Paintings on the interior surface of NE1, NE2, NE3 and NE4 domes are all affected by humidity.
The squinches of the NE domes show a cracking pattern similar to that
of the NW group. Particular attention should be given to cracks visible on
the east squinch and west, east and south arches supporting dome NE1; cracks
above the north window arches, east door and south arch below the NE2 dome
(check for crack down north wall crossing cement beam); cracks down east
and south walls to windows and west pointed arch of NE3 dome and crack on
the west arch of NE4 dome.

As is the case with the NW group of domes, the NE group has been damaged
by the insertion of a reinforced concrete frame above the arches. An exception
is the south wall of NE4 where this frame was not inserted. As for the NW
group, the works carried out have occasioned the loss of wall paintings and
weakened the masonry structure.

58. East vaulted room

The brick masonry vault exhibits vertical cracking on the NW corner.
The vault has been cemented on about 2/3 of the interior surface. This work
represents an unnecessary addition which will not resolve any existing structural
problems, and will, in fact, trap rain-water in the brick masonry between
the interior surface and the outer coating.

The north tympanum of the vault has been cemented from the top half way
down to its base.

Check crack in the NE corner near the base of the vault.

Both walled doorways to the prayer hall should be investigated and checked
in detail.

All three window openings on the east wall have been partially walled
and show cracks near the point of the arches. The wooden lintels at the
springing level of these arches are rotten and some have been removed.

The rest of the east wall does not show significant cracks.

A crack eccentric to the apex line of the vault and following the brick
courses of the vault appears towards the south end of its surface.

None of the interior crack patterns show on the outer coating of the
vault.

Two south doorways, one to the SE minaret and the other to the south
vaulted room are partially walled. The tympanums above both doorways on
the south wall are broken.

The lower part of the south wall has undergone cement pointing and been
prepared for cement work.

Door openings on the north and south ends of the west wall appear walled.
The central doorway shows cracking in the tympanum panel, and the lintel
and carpentry are missing.

The area at the NW corner is enclosed by a wooden screen of three tombs.
This section should be investigated.
59. **SE minaret base**

   In order.

60. **South vaulted room**

   This room is now used as a school classroom.

   Paintings on the interior surface of the central dome have been badly affected by humidity. Both flanking vaults are characterized by humid surfaces and falling plaster.

   The cement work on the lower part of the walls in this section has increased the dampness level.

   Floor has been cemented.

   North wall openings to the courtyard and the SE funerary pavilion should be investigated.

61. **South vaulted entrance to the courtyard and room adjacent to the SW minaret**

   Both are used as school deposits.

   Both reveal humidity problems on the ceiling surface.

62. **SW minaret base**

   In order.

63. **West vaulted room**

   Now used as a classroom.

   Central longitudinal crack following the point line of the vault. Its surface contains patches of humidity. Fortunately, no plasterwork has been removed in this room. Broader investigation of cracking in the masonry structure should be carried out after the inspection of the plaster surface is completed.

64. **Courtyard and funerary pavilions**

   All this area has been badly affected by ill-advised work featuring Portland cement. The addition of a flat reinforced concrete slab along the NS and WE axes, of cement rendering on plastered surfaces, the insertion of reinforced concrete in the sections of masonry pillars, cement paving, and a careless attitude towards the existing original elements and features has caused irreparable loss and has introduced dangerous stresses that will affect the remaining masonry structures.

   Monitoring of movements on the new structures and a thorough study for the protection of the remaining elements will be necessary.

65. **South vaulted outer fabric**

   The east end room was locked. It is used as the school library.
Rooms flanking the south gateway show variable humidity levels in the walls. In both rooms the surface of the floor has been cemented.

The west end room was locked. It is used as the watchman's room.

66. South gateway

Check for rain-water penetration through the domes.

67. Basement

All ceilings and wall surfaces have been recently cemented.

Crack on the surface of the west wall revealed humidity problems in the masonry structure.

A longitudinal crack on the vault along the north corridor appears on the surface of the cement rendering.

The east end room also contains patches of humidity.

This whole section is used as a book deposit by the schools in Taiz.

Description and assessment of repair works executed or in progress during the inspection period

68. Exteriors

Buttressing of the north and south sides of the east gate portico and partial closure of the arch openings. The centrifugal deflexion of the north and south supports is caused by thrusting action of the east arch and the dome of this portico. Both supports show defects in the original construction and have suffered from deterioration and removal of the stone masonry. In fact, the whole structure of the east arch has been recently reconstructed. The height of the new buttresses will act against the thrusting, but it favours a secondary bulging effect on the top of both supports, and in particular in the north side.

Removal of wooden lintels and insertion of reinforced concrete members in the springing line of window and door openings of the north and lateral façades. Since the original wooden members were not structurally significant, apart from supporting the gypsum fan window panels, no good reason for such replacements exists. In addition, the new insertion permits rain-water to accumulate in the window opening, besides which it seriously alters the façades' composition by the introduction of a false modern feature (Figure 5).

Waterproofing of the dome of the SE funerary pavilion. This work was done using Portland cement mortar and extended to the drum of the dome and the surface of the west wall of the pavilion. Irrespective of construction requirements, three negative aspects of this work are: physical, chemical and mechanical incompatibility of Portland cement with gypsum and clayish mortars; blockage of the normal loss of moisture from the core of the masonry structure; and, rain-water penetration through micro-cracks.

Construction of a flat reinforced concrete slab above the open corridors between the funerary pavilions. The disadvantages, the danger of irreparable damage, and the disastrous aesthetic effects of such work are blatant.
69. **Interiors**

Reinforced concrete frames in the load-bearing structures of the two groups of small domes on the prayer hall (Figure 6). This work, effected no doubt with great ability and courage, was designed to join the supports of each dome in order to reduce the loads on the arches and to act against the thrusting effect of the domes on the lower structures. In practice, however, none of these aims has been accomplished. An obvious misunderstanding of the principles of statics, of the traditional building technique, of the behaviour of reinforced concrete, and of the real condition of the masonry structure, has resulted in serious damage being done through works carried out in good faith, but imprudently. At this point we can assert that:

70. **The load-bearing masonry structures of the domes have been weakened.**

The width of the walls of the perimeter of the prayer hall has been reduced by about 40 cm. These walls vary in width from 1.40 to 1.20 m. The intermediate internal walls above the arches have been reduced by about 80 cm (40 cm on each side). In both cases the material was removed to insert the reinforced concrete beams that form the frame. No matter what procedure was followed, it is clear that the stability of these structures would have been seriously affected (Figure 7); and, given the physical and chemical incompatibility of cement with clay mortar, the original compact nature of those structures has not been restored or reinforced by the insertion of the concrete framing.

71. **The loads on the lower structures have been increased.** The substitution of clay mortar and masonry conglomerate with the same volume of reinforced concrete has increased the loads on the lower structures.

72. **The reinforced concrete frames do not perform a structural function.**

Poor quality adhesion of the masonry structure and the concrete frames does not allow both structures to work together. Furthermore, the mixing water in the concrete addition has been probably absorbed by the dry mortar of the existing structure, particularly by the area used as a bed for the beams. The damage is double: the upper part of the concrete beams has been weakened and the imbibition of the cast bed has been favoured, thus causing an additional settlement in the structural system. A visual inspection suggests the framing system is not connected or fixed vertically in the corners. If this is the case, as it seems to be, then the concrete frames only represent an additional dead load. In order to evaluate the "beam" function of the reinforced concrete frame, so as to determine whether or not these lighten the loading on the lower arches, it is necessary to know the position, diameter and quantity of the steel bars in the beams. Unfortunately, no one at the site was able to provide information concerning these specifications.

73. **Important evidence has been destroyed by cutting the walls section.**

Given that this is a religious building, it seems strange that no objection was made to such work. In fact the net result was the intentional destruction of about 6 m² of wall paintings. These paintings represented inscriptions consisting of big white characters over a red-brown surface. These characters were the best preserved of all the epigraphic features since they were kept under only one layer of whitewash. The stucco decorations are now almost unreadable because of the numerous layers of whitewash with which they have been covered. With the destruction of the central part of the painted inscriptions, one of the few possibilities of learning about the various building phases of the mosque has been lost.
The removal of gypsum plaster and its replacement by Portland cement destroys evidence and damages the masonry structure. Apart from the negative effects of Portland cement previously mentioned, and the destruction of dates, graffiti, and other popular inscriptions that could be recorded on the old "intonaci", these works have caused damage by laying bare the clay mortar and the wooden structural courses. With the total evaporation of residual water in the wall mortar, a sudden increase of moisture from the cement work has followed. The crumbling of the old mortar, and the swelling of the wooden members have created additional unbalance in the load-bearing masonry walls. This problem is particularly serious in the north wall because of its height, the exposure of a larger surface, and the structural design of the fabric of the mihrab. These works were immediately stopped in order to avoid further destruction of the old "intonaci" and damage to a secondary mihrab, (Figure 8) (to the east of the principal mihrab). Few persons seem aware of the existence of the secondary mihrab.

Other works. The construction of classrooms along the south façade of the mosque does not structurally affect the building, but this extraneous addition seriously compromises the building from an aesthetic point of view, especially when it is seen as a relevant example of Yemen's cultural heritage. (See also the "Addendum" to W.H. Cary's report, September 1979.)

The reconstruction of the southern retaining wall was almost finished during the period of our visit. This should be completed.

Original building materials and systems used in the mosque

These notes are limited to the results of visual survey; therefore, possible modifications or additions could result from broader investigations.

The materials and building systems used originally in the mosque are as follows:

Stonemasonry: consisting in oblong blocks of granitic material, probably quarried through the levelling work on the rock bed on which the mosque stands. The blocks lay on an impure clayish mortar following horizontal courses. At regular interval heights of about 1.20 to 1.50 m, the walls were re-levelled by rough squared wooden courses or beams, with a section of about 10 x 10 cm. Similar beams can be found in the corners of the walls and immediately below the springing line of the arches inserted in the place of the traditional abacus. The width of the walls built with this system varies from 0.50 to 1.50 m. This type of masonry, with insignificant variations, has been used in most of the vertical structures of the fabric of the mosque. The exceptions are described in the following paragraphs.

Brickmasonry: forming walls with widths of one or three modules following the width of the brick unit (0.25 and 0.75 m). The approximate dimensions of the brick unit are: 0.22 x 0.22 x 0.04 m. The brick units appear fragile; this is probably due to poor firing. In fact, most bricks are damaged on the edges and corners. This type of masonry has been used in all thrusting structures (arches, vaults, domes, etc.). With the exception of the outer structure of the mihrab on the centre of the north façade and the upper levels of both minarets, this system has not been used anywhere else as a vertical support or load-bearing structure.
81. **Carved stonemasonry:** the cutting, carving and finishing of surfaces, executed with great skill, point to the use of three kinds of stone: an ivory-white limestone (matching the old gypsum plaster) and what would appear to be reddish and grey-green porphyrites. The white limestone has been used in the entrances to both minarets, and also in that of the southern vaulted hall; all three stones are employed in the decorated architraves. White limestone has also been used for two other architraves (both with carved inscriptions): one above the south door and the second above the door to the hall below the prayer hall. The other two stones were used to build the south entrance portico with interesting chromatic results. The dome on this portico, as is true of all the others, was built with brick. By examining the stonework, the quality of the stonemasonry, and the general features of the decoration, it is easy to deduce that the south entrance portico is a unique late addition to the fabric of the mosque. Also in this fabric, we noted the insertion of small levelling wooden beams.

82. **Gypsum works:** gypsum was used in the mosque in four different ways: in external and internal "intonaci" or plastering; to whitewash wall surfaces; to mould fascias and other decorative panels, and, on the roof's surface. Particular interesting features of the gypsum work appear in the epigraphic fascias, on the walls and the multifoil arches of the funerary pavilions, and on the canopy above the niche of the mihrab. The overhanging elements of the gypsum decoration have an interior reinforcement in marsh cane. Unfortunately, the mihrab's canopy is in bad condition.

83. The roofing surface was conducted using a procedure or technique known as *gadad* (the word probably derives from the name of a town in which this technique was developed by local craftsmen). The system consists in applying layers of gypsum which are pressed and polished over a course of brick detritus mixed with a lime mortar. The polishing is done with stones until the surface is compacted and has a marbled appearance. This surface is, in fact, waterproof, but not elastic. Therefore, any movement of the fabric, either structural or thermal, will easily cause surface cracks. Once the surface cracks, repair works are always difficult and imperfect. This surface presents problems similar to those of the cement rendering; normal shrinkage of the material and microcracks permit penetration of water that will not evaporate. A field test carried out on one of the cracks between the central dome and one of the small lateral domes showed a high moisture content in the infill material under the surface layers. This test was done two weeks after the previous rainfall.

84. This simple boring test also confirmed the initial hypothesis concerning the building system of the mosque and its difference from those commonly used in civil construction. The fabric of the mosque, as we mentioned before, consists of different and autonomous structural units and systems, all of which were probably built in separate periods. This explains why, in spite of the numerous cracks visible on the structures, no serious proportional subsidence or translation of the whole fabric has occurred. The best example is provided by the two vertical cracks that virtually cut the central dome hall in two. Both cracks, contained in a plane parallel to the qiblah wall (east-west), start at the base of the central dome coming down through two small window openings and then along the flanks of a system of blind niches down to the upper parts of both principal piers. These cracks, without doubt the most significant faults identified in the mosque, would have been disastrous in a monolithic or compact structure (see section).
85. Ornamental features and surface decoration include: gypsum work, wall paintings and woodwork.

**Gypsum work**

86. Apart from the epigraphic fascias many other decorative elements are made of gypsum. Most form part of the decoration of the prayer hall and of the three funerary pavilions. They include the big shields between the arches of the central dome's hall, the shell-shaped semicircular vaulted niches, the false screens above the principal arches, the qiblah canopy, window tracery panels (screens) - most of which are unfortunately lost - and all the outer wall decoration of the funerary pavilions. All of these elements bear witness to a rich decorative fantasy and skilful craftsmanship in relation to gypsum work.

**Wall paintings**

87. Large areas of the internal surfaces of the mosque are covered with paintings. These seem to militate against the perception of a well-balanced and proportioned architectural space. However, regardless of their aesthetic value in the architectural ensemble, all of these paintings are of great historic importance, and represent a decorative taste. The paintings of the Mutabiyah seem to correspond to the same period, but a precise dating of the Ashrafiyah paintings can only be made following broader investigations. It is important to note that some remains of red and pink pigments were identified on the external surface of the drum of the central dome, the crenellations, the plaster of the west minaret and the surface of the walls of the courtyard. However, none of these pigments seem to relate to the original construction.

**Woodwork**

88. Although the short inspection period did not permit detailed examination of them, the existence of magnificent pieces of woodwork should at least be mentioned. These are: the wooden screen-panels of funerary pavilions, the screen-panels of the catafalques, and the doors of the west gate. The screens show extremely interesting design characteristics and high quality craftsmanship. The doors of the west gate can be considered as real masterpieces of wood carving. Further investigations and studies of the design features could result in a valuable contribution to the art history of this region and help towards a precise dating of these objects.

**Historic data and construction phases**

89. Since the main aim of this mission was to assess the structural condition of the mosque, there was not enough time to look for evidence concerning the different construction phases of the mosque or to identify the related historical events. It is important to point out in this connection that such an investigation is not only essential in order to understand the physical and social life of the mosque, but, above all, is required in order to establish the broad lines of a comprehensive programme of consolidation and restoration of the building. It will help, for example, in the evaluation of structural faults related to the growth or the addition of fabric to the building. A quick examination of the plans and a visual inspection of some of the critical
points in the building suggest that there are many more construction phases than those mentioned by R.B. Lewcock. According to Lewcock, such phrases are limited to: the addition of the east, south and west ambulatories, together with the three gates; the addition of the ablution area; and, the three funerary pavilions. It would appear, however, that the construction of the mosque was much more complicated, especially in so far as concerns the first prayer hall, the original shape and size of the courtyard (shamsī), the date of construction of both minarets, and that of the south portico. In any event broader investigations into roof surfaces, wall joints, foundations, etc., will be necessary to verify the numerous hypotheses in this matter. These investigations will result in an important contribution to the architectural history of Taiz and Yemen.

Consolidation and restoration of the mosque

Brief considerations on the use of Portland cement

90. The use of Portland cement in structural repair works, new renderings, roof waterproofing, etc., is, unfortunately, spreading in Yemen and abroad. Experience shows that, with the exception of its use in modern construction, or in particular cases of barrage or foundation consolidation, this material should not be employed in restoring historic buildings. Portland cement should never be mixed with traditional materials such as gypsum, lime, stone masonry with clay mortar, etc. The reasons for this precise restriction are many and are based on a wide experience with hundreds of islamic, and non-islamic historic buildings. Among the reasons in question are the following:

with the exception of sand and steel, no other material shows good binding with Portland cement;

Portland cement, at equal volume of mixture, weighs more than any other traditional binding material;

Portland cement, after setting, is only impermeable if there is not surface cracking. What appears to be an unquestionable advantage can also be extremely dangerous. In practice, cement does not permit moisture evaporation from the walls. At the same time, the moisture content of the walls is increased with the mixing water of the cement mortar. In the case of the specific characteristics of the wall masonry in the Ashrafiyah mosque, this means a weakening of the structural capacities of walls. The height of rising damp in the inspected building varies from 30 to 40 cm (in walls plastered with gypsum) to 1.80 to 2.00 m (in walls with cement rendering);

Portland cement, when used for surface coatings, is easily damaged because of shrinkage and thermal movements. A cracked cement surface is useless and dangerous since it allows water penetration and does not favour its evaporation;

structural repair works with Portland cement are "irreversible". Where changes are contemplated it cannot be easily removed without causing further damage to the original historic fabric;

Portland cement is a new product created to work in new and modern structures. A hundred years have passed, more or less, since it became an industrial product. But traditional materials (those, for example, used by Muslim builders) have been in use for thousands of years. Can Portland cement boast such an experience?
Repair of the complex, control of humidity

91. As has already been mentioned, numerous faults have been identified in the whole complex. These faults vary in importance and do not necessarily indicate a critical static condition or a danger of imminent collapse. On the contrary, the individual structural elements seem to endure the action of external factors that are the cause of premature structural deterioration. All of the faults in question can be repaired once the nature and condition of all vertical support foundations, the way in which these stand on the bedrock, the characteristics of foundation joints, etc., have been properly investigated. Boring in critical points will be necessary (downhill north wall foundations, uphill minaret foundations, etc.). This work will also be useful to check the extremely dangerous structural deterioration due to occasional action of underground water, which is generally the cause of skidding movements in foundations. Another problem already partially dealt with by the local authorities, is that of the appropriate drainage of rainwater and that of the correct function of the sewage systems of the whole area surrounding the mosque. Apart from these works, it will be necessary to investigate all of the old drains and sewers, still partially visible at the south-west corner of the courtyard and near the entrance to the rooms beneath the prayer hall. Once they have been investigated and restored, these systems should be integrated, if possible, with the new systems. Water infiltration from the small pond at the east ambulatory should be checked.

The problem of roof drainage is treated in the following paragraph.

Consolidation of individual architectural elements, roof structures and surfaces

92. Clear statements have already been made in this report concerning the use of traditional materials and systems in the consolidation of historic structures. However, the exclusion of non-traditional materials from these works should not necessarily be taken as an absolute restriction. Occasionally, the appropriate use of modern chemical products, metal tie rods or even water-tight bulkheads and concrete piles can help stabilize foundation soils or consolidate other structural elements. The previously mentioned restrictions are applicable, in particular, to conservation works on the original masonry, on load-bearing structural members and on decoration work. Non-traditional materials should never be placed in contact with the fabrics in question unless these can be easily removed without damage to the original structures. Following this proviso, we now pass to a brief description of simple procedures for the examination, repair and consolidation of individual architectural elements.

93. It will be necessary during a favourable season, and working on surfaces no larger than 80 to 100 m$^2$, to totally remove the roof's plaster coating and all of the infill material between this coating and the extrados of the vaults, domes, arches and head tops of walls (shoring of critical elements should be previously set). All inert material and dust collected on the extrados surfaces should be removed. In the case of the surface it will be possible to proceed with the examination and control of all real structural faults since these will be visible only after completion of the operation described. The next step will be to repair and consolidate the structures, using traditional methods and materials where possible. Re-pointing of all the roof masonry joints will be necessary. In some cases, the replacement of original mortar by a fresh one may be called for. The use of admixtures in the new mortar is not excluded. On completion of the roof restoration, a galvanized metal mesh will be fixed to the roof's surface with brass or
stainless steel nails. Careful gadd work will complete the roof surface treatment. Particular attention should be given to the joints on this surface since these are critical when waterproofing a roof. These joints should preferably correspond to the water run-off ridges, where, if necessary, plastic sealants should be used. The restitution of roof slopes, should take into consideration a quick flow of rain-water in correspondence with structural needs, walk-paths on the roof, and the location of gutters, drips and larmiers. All gutters need to be repaired.

94. As for the minarets, both seem to be in good condition. However, simple repair work, regular maintenance and regular check-up of internal and external wall surfaces, of the vaulted staircases and wooden structural members, are necessary (Figure 9). Repair work is also necessary on the eight upper openings of the top balconies and on the horizontal uncovered surfaces of the first and second balconies and top domes.

95. Examination of external and internal wall surfaces has revealed numerous cracks. The walls of the prayer hall are the most affected. These cracks appear on either plastered or decorated surfaces. All should be carefully checked, preferably after removal of the surface plaster. In special cases, surface decoration may have to be detached from the affected walls; this intervention should be carried out by specialists in line with well known procedures. The exact nature of these faults, the possible causes and their seriousness can only be evaluated after completion of these operations. The next step will be to repair each crack employing procedures similar to those described in the case of the roof structures.

Consolidation of decorative work

Gypsum mouldings

96. In order to establish the degree of deterioration of these decorative features, the cohesion of the material, its adhesion to the supporting walls, etc., it will be necessary, at first, to remove the numerous layers of whitewash covering the original stratum. This intervention can only be carried out by qualified personnel. Once the original surface is visible, it will be possible to decide on the interventions needed: surface consolidation, structural consolidation, fixing, etc. The holes and lacunae will serve, at first, to reinforce the anchorage of the decorative panels; then the lacunae will be filled up with a similar gypsum mortar without completing the missing features. The restoration of missing surfaces is justifiable only by static requirements, where original features may fall down or be damaged as a result of present structural conditions. In this instance, the reconstruction of the structure may be carried out, but, without repeating or completing the decorative features. A good example of such a case is provided by the gypsum "tracery" of the multifoil arch of the NE funerary pavilion, in which the hexagonal screen needs to be completed in order to prevent its collapse. The same treatment should be given to most of the gypsum screens above door and window openings. A broken screen does not perform its function and is always in a dangerous condition.

97. In extreme cases, there may be a need to detach decorative panels from walls affected by rising damp (unfortunately, this problem will soon be evident in the walls of the SE funerary pavilion). In other cases, decoration detachment will be necessary to complete structural consolidation of load-bearing elements. In both cases, after the necessary treatment, the decorative panels should be placed back in their original location.
Woodwork consolidation

98. A first step here is the complete removal of the layers covering the original pigmentation (water-colours or "tempera", fixed with organic glues). In other cases, it will be necessary to expose the wood surface and proceed with the impregnation of the material with insecticides, and if possible, with waterproofing and fireproofing treatments. On completion of the consolidation process, the restoration, or replacement of irrecoverable parts will be carried out. A similar procedure should be followed in the case of the wooden beams inserted in the masonry walls. Those that have to be re-plastered should be first protected with jute fibres or a similar material previously immersed in an appropriate glue.

Wall paintings

99. On completion of a thorough examination of the characteristics and condition of the wall paintings, it will be necessary to prepare a programme for their cleaning, consolidation and eventual restoration. Also in this case, it may be necessary to detach surfaces with wall paintings in order to consolidate the supporting walls. An approach similar to that described for the restoration of gypsum restoration should be employed in these works.

Completion of the documentation

100. The consolidation and restoration of the mosque and its eventual total recuperation and re-use cannot be accomplished without relevant documentation. Such documentation forms the necessary basis for a serious and broad programme of interventions drawn up in the light of historic and artistic information on the building and its evolution. It should include: documentary research on literary sources (not limited to al-Kharrarji alone), interpretation of wall inscriptions, research (in situ) on the construction phases, a comparison of references concerning other religious buildings in Taiz and Yemen, preparation of a complete set of measured drawings of the entire complex and of particular details (for these purposes the only available drawing - the ground plan - and the section we prepared are not precise enough), research on photographs, drawings and other graphic documents, etc.

101. In addition, every step of the restoration process should be completely recorded.

Creation of a preservation area or zone (harim) around the mosque

102. This recommendation holds good also for all other buildings of historical and artistic value in Yemen. The demarcation of a preservation area (harim) around important buildings in the Muslim world has already been carried out in the case of many of these buildings. The area specified will vary in surface in relation to the surrounding environment. In any case, within this area it is absolutely forbidden to introduce additions or changes to existing buildings or to alter street conditions. This action is designed to accomplish two things: to assure the equilibrium of the foundation bed of the area around the protected building (microgeological equilibrium), and, above all, to preserve the natural and physical environment associated with the building, in the period of its construction.
103. The al-Ashrafiyah mosque has already been affected by uncontrolled building on the surrounding fronts. The north front, for example, is partially blocked (NW portico) by the appearance of private construction in front of the north wall. The same thing could happen on the west front with the addition of one or two levels to the existing buildings.

104. Therefore, the preservation area (harim) for the al-Ashrafiyah mosque should extend, at least 25 m on each side of the complex, with additional regulations for new construction in the surrounding quarter. The creation of the preservation area should fall within the legal competence of the municipality of Taiz, with the official approval of the Ministries for the Awqaf and Culture. These three authorities should be jointly responsible for seeing that the regulation is respected and that there is regular maintenance of the mosque.

105. Without regular and continuous maintenance, all the efforts and expenditure associated with consolidation and restoration work will be absolutely useless, and a dangerous precedent will be established which could adversely affect the safeguarding of other historic buildings.

Conclusions and recommendations

106. The al-Ashrafiyah mosque is an architectural monument of unique value.

107. Through a visual structural survey carried out during the period 10-12 April 1980, numerous important faults have been identified and should be seen to as soon as possible.

108. The building can, and must be saved.

109. The salvage interventions will be costly and long lasting.

110. The intervention programme cannot be entrusted to partial initiatives based on good faith; on the contrary, each step must be carefully programmed and supervised by qualified personnel in the conservation field and should promote the use of local craftsmanship and traditional materials and techniques.

111. Even if they have been done in all good faith the works carried out from July 1979 to the present are not scientific and have not resolved the problems of individual buildings nor of their architectural components.

112. No further work should be considered without the permanent supervision of qualified architectural conservators, engineers, surface conservators, archaeologists, historians, etc. Conservation is a multidisciplinary field.

113. The conservation programme should be undertaken within the framework of a joint plan involving the Yemen Arab Republic (Ministry for the Awqaf, Ministry of Culture, Administration of Antiquities and Libraries, National Museums of Sana'a and Taiz, the County Council and municipality of Taiz), Unesco, and the consultancy, technical and training assistance of ICCROM.
References


Figures and drawing of mosque