

THE CONSERVATION OF THE DOME MOSAICS OF HAGIA SOPHIA

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SUMMARY

The International Project of the Hagia Sophia Dome Mosaics is carried on since 1992 by a team from Central Laboratory for Restoration and Conservation (Istanbul), together with international experts from several countries and it is supported by UNESCO World Cultural Heritage Center. The project has the primary aim of stabilising the vulnerable areas of mosaic and later painted surface decoration in the northeast (completed in 1999) and in the northwest quarter of the dome.

INTRODUCTION

Justinian's church of Hagia Sophia erected in the 6th century A.D., is one of the unique monuments that has survived throughout the centuries. The present dome, still that of A.D. 562, is the first big dome of the Agricultural Revolution Age. After the opening of the church in 537, severe earthquakes damaged the building. The first partial collapse occurred in 558 at the central part of the main eastern arch and part of the dome resting on this section. The dome of today is the entire second dome, rebuilt to a higher profile. The second collapse occurred in the tenth century and involved the main western arch and part of the dome thereby. In the 14th century the eastern arch and a part of the dome gave way for the second time.

The first investigations of the uppermost levels - including the dome - of Hagia Sophia began in 1992; different areas of original mosaics date from the sixth, tenth and fourteenth centuries?1?. Later addition and repair dating from the middle of the nineteenth century onwards include the

calligraphy at the peak of the dome. The first of the later interventions, termed the “Fossati intervention” by the conservation team, was carried out between 1847 - 1849. Hagia Sophia was restored extensively during the reign of Sultan Abdülmecid (1839 - 1861) by the Swiss Architect Gaspare T.Fossati and his brother. Following the earthquake of 1894, the building was closed for repairs, during which great zones of plaster were replaced and painted. The second intervention then occurred after 1910 but quite a while before inauguration of the monument as a museum in 1934; it was carried out under the General Directorate of Pious Foundations. This is indicated as the “Vakif (Foundation) intervention “.

A survey reveals the following areas and percentages represented by the historical surfaces.

Original mosaic	1000 m ²	ca. 53 %
First intervention	280 m ²	ca. 15 %
Second intervention	560 m ²	ca. 29 %
Total loss	60 m ²	ca. 3 %

The total surface comprises as much as 1900 m².

In 1993 a large tube scaffolding was erected in the northeast quarter of the dome between ribs 29 and 40. From the cornice of the dome rise forty ribs and the surfaces are decorated with geometrically patterned mosaic. Between them are the arched reveals where the windows are set. They have a numbering system from 1 to 40 beginning in the center on the east side and it works clockwise. In this part of the dome one could reach areas of sixth- and fourteenth-century mosaics as well as one quarter of the nineteenth century painted and gilded calligraphy. Areas treated in both the first and the second interventions were also accessible. In summer of 1999 the scaffolding was moved to northwest quarter of the dome between ribs 20 and 30. The repositioning of the scaffolding makes it to access part of the sixth century and tenth century mosaic as well as a second quarter of the nineteenth century painted and gilded calligraphy at the apex of the dome and also nineteenth and twentieth century restorations in this part.

STATE OF PRESERVATION OF THE SURFACE OF THE CENTRAL DOME

Preservation is partially related to the materials employed in different periods. In general, losses at the mosaic surfaces include cover - glass flaked from compound tesserae and / or total loss of individual tesserae with part of preparatory drawings exposed beneath, as well as deep lacunae. The original sixth-century mosaics were very finely executed, employing small glass tesserae, some gilded with gold and silver. The tenth and especially fourteenth century reconstructions make extensive use of salvaged tesserae from the earlier work. The fourteenth century execution is very crude in comparison with larger stone pieces substituting for the silver ground, and a re-use of sixth century tesserae for gold tesserae. A combination of gold and silver, green, blue and red glass is typical of this period. There are some areas where detachment of the mosaic mortar from the brick support is most alarming; in certain areas the rendering itself has already been lost. Quite a considerable number of copper and iron nails and cramps have been found inserted at the junction between the sixth and fourteenth century mosaics. Numerous single tesserae must be refixed, and there is extensive overpaint on tesserae surfaces from the earlier interventions.

The calligraphy of today in the center of the dome was executed by Hattat Kazasker Mustafa Izzet Efendi during the Fossati intervention between 1847 - 49 ??. It has also been extensively damaged by iron nails rusting within the plaster of decoration. Fluctuations in temperature and humidity cause the movement of the soluble salts and subsequent lifting and flaking of the paint layers. A large number of painted plaster discs have already been lost and many more loosened by the expansion of the rusting metal ??. During the procedure of opening 143 holes with some 200 nails, no mosaic remains or any tesserae from the earlier periods were found in the northeast area of the calligraphy. In the northwestern area, there are fewer nails than in the last. The expansion of the nail heads has resulted in the detachment of some fifty discs of painted plaster. Those of sub-surface fixings that have not yet started to cause damage at the surface, were left in situ as it would cause unnecessary damage to try to extract them. The plaster has three layers of lime mortar and containing straw as filler ??. The Fossati oil paint (1st intervention), which coagulated, has very often been overpainted with the dull colors of the "Vakif (2nd intervention) period". Flaking, however, is to be seen in the "Fossati zones" as well as in those of the second intervention. Although the lacquered coating of the surfaces of the "Fossati intervention" have browned with age, those of the 2nd intervention - without gold leaf - have proved less resistant to condensation and have suffered greater damage.

TECHNIQUES OF EXECUTION OF THE MOSAICS

Detailed investigations into the methods and materials used during the various periods of mosaic decoration has revealed characteristics individual to each historical era. There is a progressive deterioration in both the workmanship and the quality of the materials employed ?5?.

THE SIXTH CENTURY MOSAICS (A.D.558 - 562)

At the north and the south sides of the dome there are two large separate zones of sixth - century mosaic preserved. The supporting structure consists of large bricks (averaging 35 cm in length and 6 cm in thickness) with a trowel-finished pointing nearly equal to the thickness of the bricks. The mortar appears to be a characteristic lime / crushed brick pozzolanic mixture. The preparatory drawings were executed in fresco manner directly onto a fresh bed of lime. The glass tesserae decoration is quit consistent in size. The quality of both the materials and the workmanship was very high. The decorative elements were rendered in opaque tesserae of red, blue and green glass, and the backgrounds in gold and silver compound tesserae. The compound gold tesserae are quite regular in form averaging 6 x 7 mm. The gold tesserae of this period set densely (an average of 180 per 100 cm²), produced a strong reflection of light . The silver tesserae are similar in size and were produced like gold; the spacing however is not as dense (an average of 160 per 100 cm²).

THE TENTH CENTURY MOSAICS (A.D. 989 – 995)

Tenth century mosaic has been revealed in one large area in the western part of the dome. In 1999 with the relocation of the scaffold to the northwest quarter of the dome the tenth century mosaics were inspected in detail. The bricks are more or less the same size (35 x 5 cm), and the pointing displays a similar thickness. The tesserae were evenly laid, but at wider intervals than in the 6th century, and there is evidence for reuse of glass pieces salvaged from the earlier mosaics. Although the backgrounds of gold tesserae are similar to those of the sixth century, the wider spacing (an average of 160 per cm²) results in 10% less reflection. The spacing of the silver tesserae remained the same as in the sixth century mosaics.

THE FOURTEENTH CENTURY MOSAICS (A.D. 1346– 1353)

Mosaic from this period covers quite a large area in the east of the dome, and here an obvious decline in standards is apparent. A loss of skill in the mosaic tradition, as well as lack of money and shortage of materials is reflected in this crude imitation of the earlier execution techniques. The bricks in the structure here are thinner (35 x 3.5cm), while 1:1 ratio of brick to the lime / crushed brick pointing mortar (3.5 cm thick) remained unchanged. The preparatory drawing was again executed in fresco technique onto the wet bedding. The mosaic itself was very carelessly executed. Plaster levels, as well as the techniques of setting (e.g. spacing and orientation) are irregular. Some tesserae lines were omitted and supplied by painting; there is overpainting on gold tesserae as well to define completely missing outlines. A considerable number of salvaged coloured glass tesserae in the gold background together with silver and impaired gold fragments spaced at still wider intervals (an average of 140 per 100 cm²) provides 25% less reflection. There must have been a shortage of gold tesserae and a need to be economical. Crudely cut tesserae of grayish white marble now served as a pure substitute for silver areas (which averaged only 40 pieces per 100 cm²).

LATER SURFACE ORNAMENTS

Later phases of surface decoration include the calligraphy at the apex of the dome from the Ottoman period after 1710, as well as the work of the first and second interventions 1676. Ornament from the first intervention was executed in ochre oil paint or tempera over a gypsum base rendering. This was overlaid with gold leaf and red stencilled pattern with the form of *trompe l'oeil* mosaic, and varnished with a lacquer now brownish. The plaster from the second intervention was covered with an opaque yellow pigment in a glue medium. The same color was used for retouches to the "Fossati intervention". Stencil ornament in pattern double the size of Fossati's were applied onto this yellow ground.

CONSERVATION TREATMENT

Intervention on the Calligraphy

The treatment chosen for the badly flaking paint layer is to fix it with Mowiol 28/99 (polyvinyl alcohol). Powdery areas of gilding are being consolidated with Klucel HF. Most of the rusting

nails visible have been removed and the holes filled with a lime based mortar both in the northeastern and in the northwestern part of the calligraphy followed by a lime-based fine surface fill. The mortar repairs are tinted with powder pigments in water applied "*a fresco*", followed by reintegration in *trattegio*.

Intervention on the Mosaics

Emergency intervention and conservation treatment to avoid further loss of mosaic surfaces in the southeast quarter of the dome was the primary objective of the past campaigns. Thin outer layers flaked from compound glass tesserae (gold and silver) are reeffixed with Paraloid B72.. Consolidation, grouting and mortar refills have been carried out where necessary, especially at the juncture between the sixth - and fourteenth- century mosaics, to stabilize and to secure plaster bedding of the mosaics that is being detached from the brick support, cracking badly or beginning to disintegrate. In such areas the glass tesserae are loose and the embedding mortar weak and crumbling. Fine cracks and minor detachments are grouted with Injecting Mortar 6001 (Bresciani). Larger voids are grouted with lime - based hydraulic mortar. The surfaces are then pressed back into place with a system of special sprung supports. Loose tesserae are reembedded into new mortar infills. In fresco and secco plaster repairs, reintegration is achieved with dry powder pigments in water without any additional binding medium. In 1999 during the first mission at the northwest quarter of the dome, intervention was limited to the emergency consolidation of several areas where the plaster and tesserae were bulging and in danger of loss. Larger delaminated areas are particularly near the windows.

Intervention on Fossati and Vakif Periods

No remedial conservation work was carried out on these areas. Undamaged Fossati is planned to be cleaned and the varnish reduced. Big areas with many square meters is planned to be taken off in the next campaigns because of their high salt content and unpleasant appearance, to be replaced by specially prepared mortar infills.

ENVIRONMENTAL SURVEY

Thermohygrographs were placed in the northeast quarter of the dome at three points, two on the interior (one at cornice level and one at the apex of the scaffold) and one outside to evaluate the environmental conditions effecting the building. Results indicate that the temperature and humidity curves from the interior of the structure follow those from the exterior remarkably closely.

CONCLUSION

The principle treatments so far used are following:

- ?? Applying Paraloid B72 as a glaze for lost cover glass
- ?? Filling single tesserae losses only where surrounding tesserae are firmly adhering;
- conservation of preparatory painting which served as the background colors for the

tesserae setting

- ?? Cleaning Fossati lacquer with suitable material; preserving gilded and stencilled ornament with Paraloid B72
- ?? Cleaning Fossati and Vakif overpaint from mosaic surfaces
- ?? Removing mortar and painted surfaces with too high a salt content and replacing them with specially prepared mortar of high porosity to allow free migration of salt solutions without affecting either the stability of the plaster or the aesthetic appearance; integration more of stable colors into the mortar to enable the decoration to better withstand deterioration. This new mortar infill is painted *a fresco*- i.e. printed on the fresh lime mortar with a roller with symbolic reference to the past restorations using stencil techniques on painted surfaces without gold: Fossati - like stencilling in areas where such has been removed; Vakif - like stencilling in areas of previous Vakif interventions; New stencil decoration in areas of total loss

The condition of the surface decorations and rendering of different historical periods in the dome of Hagia Sophia present us with a wide spectrum of challenges. We, the conservation team, firmly believe that this dome which has been standing since the sixth century will be able to exist - with careful intervention, accurate and elaborate conservation and continued maintenance - over many centuries to come.

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