



Available online at
SciVerse ScienceDirect
www.sciencedirect.com

Elsevier Masson France
EM|consulte
www.em-consulte.com/en



Diagnostics and protection of Hagia Sophia mosaics

Antonia Moropoulou*, Asterios Bakolas, Maria Karoglou, Ekaterini T. Delegou, Kyriakos C. Labropoulos, Nikolaos S. Katsiotis

National Technical University of Athens, School of Chemical Engineering, Section of Materials Science & Engineering, 9 Iroon Polytechniou Str., Zografou Campus, Athens, 15780, Greece

ARTICLE INFO

Article history:

Received 19 November 2012

Accepted 16 January 2013

Available online 18 February 2013

Keywords:

Non-destructive testing
 Fibre optics microscopy
 Ground penetrating radar
 Infrared thermography
 Hagia Sophia
 Monument mosaics
 Bedding mortars
 Tesserae

ABSTRACT

Non-destructive techniques (ground penetrating radar, infra-red thermography, fibre-optics microscopy) were employed on south upper gallery mosaic areas of Hagia Sophia. The main aim of this on-site investigation was to evaluate the preservation state of the mosaics and the previous interventions, as well as to detect mosaics in layers below the external plastered surfaces. Results indicated that is indeed possible with the aid of NDT to locate the grid of rendered mosaics. Additionally the main environmental decay factors (moisture, salt, pollutants), areas where the mosaic materials (tesserae and bedding mortars) presented decay problems and sub-layers that pose risk of detachment or decay intensification, were identified. In this way, NDT can contribute to the development of a strategic planning for mosaics conservation, protection and revealing. In addition, consolidation materials already used in conservation interventions were assessed, with the aid of ageing tests and innovative restoration materials and techniques are proposed for mosaics sustainable protection.

© 2013 Elsevier Masson SAS. All rights reserved.

1. Research aims

In this work, the main research aims concern the application of non destructive techniques to:

- detect rendered mosaics, and provide an indication of the mosaic grid;
- assess the preservation state of mosaics, regarding the identification of defects (cracks, delaminations, voids, loss of adhesion with the substrates, etc.) in rendered or uncovered mosaics, and the determination of decay factors and products;
- assess of the performance of previous conservation interventions.

2. Introduction

The church of Hagia Sophia in Constantinople is an important monument of the international cultural heritage, on account of its unrepeatable structural combinations and unique internal mosaic decoration. The church is decorated with mosaics dating back to the fourth century; however, throughout its history the building has been damaged by earthquakes, vandalism, and has been the subject of various interventions. Regarding the mosaic decorations,

a significant portion of the mosaic decoration that has survived through centuries, has been covered during the conversion and subsequent use of Hagia Sophia as a Mosque. Since 1935, when Hagia Sophia was converted into a museum, conservation of the remaining non-covered mosaics has begun, and also mosaics that have been revealed from areas where the plaster was removed.

In the context of a bilateral Greek–Turkish cultural cooperation agreement [1] an array of non-destructive techniques has been used in the past for the assessment of the preservation state of the structure of the church of Hagia Sophia [2,3] and its mosaic decoration [4–10]. This past experience demonstrated the ability of non-destructive techniques to reveal information necessary for effective conservation interventions. A previous diagnostic study using Non Destructive Techniques (NDT) on the dome mosaics by National Technical University of Athens (NTUA) research team had been carried out in 2000 with the collaboration of UNESCO conservation team, under the permission of the former Director of Hagia Sophia Museum S. Turkoglu.

A diagnostic study using NDT on the south upper gallery mosaics by NTUA research team, took place in 2010 in the framework of ELAICH course (EUROMED Heritage IV Program), which was coordinated by the Bogazici University and Prof. M. Erdik (scientific responsible), under the permission of A. H. Dursun, President of Hagia Sophia Museum. In the south upper gallery area, plastered surfaces, dating back to Fossati interventions (1847–1849) were partially uncovered and cleaned by the Byzantine Institute between 1931 and 1949 [11]. Recently, Istanbul Directorate of Surveying and Monuments, Ministry of Culture and Tourism of

* Corresponding author.

E-mail addresses: amoropul@central.ntua.gr, abakolas@mail.ntua.gr, margo@central.ntua.gr, edelegou@central.ntua.gr, klabrop@central.ntua.gr, ni.kappa@gmail.com (A. Moropoulou).

Turkish Republic, performed incisions on plastered areas revealing underlying mosaics.

This NDT study aims to contribute to the development of a strategic planning for mosaics conservation, protection and revealing, by evaluating the preservation state of the mosaics, and assessing the performance of previous conservation/restoration interventions, in order to plan and apply, on a pilot scale, compatible interventions for bedding mortars and tesserae consolidation and protection.

3. Experimental procedures and techniques

The surfaces under investigation were selected based on several criteria and approved by the Museum Technical Directorate. Three areas were investigated located at gallery level (Figs. 1 and 2). Area 1 of investigation is located at a perpendicular intersection of two arches (a north east bracing arch) and it includes recently revealed ornamental mosaic areas, exposed brick structure and exposed stone structure. Area 2 is located between windows at the south masonry of the south upper gallery. Part of the plastered area has been removed revealing the underlying mosaic. The interesting thing about this area, in comparison to Area 1, was the fact that this is located on the interior of an external wall, thus is exposed to the effect of exterior environmental factors. Both areas contained mosaics revealed by recent conservation/restoration interventions. However, there were indications that mosaics were present in the adjacent areas, and thus the NDT were employed to verify these assumptions and applied both on revealed mosaics, and plastered surfaces. Area 3, corresponds to an already revealed figural mosaic of Constantine IX and Zoe by Byzantine Institute. In this case NDT was applied in order to diagnose the preservation state of mosaic. This mosaic is also located on the interior of an east external masonry, and a past cement intervention is present at its lower part.

In particular for the in situ investigation of gallery mosaics, ground penetrating radar (GPR), infrared thermography and fibre optics microscopy (FOM), were used:

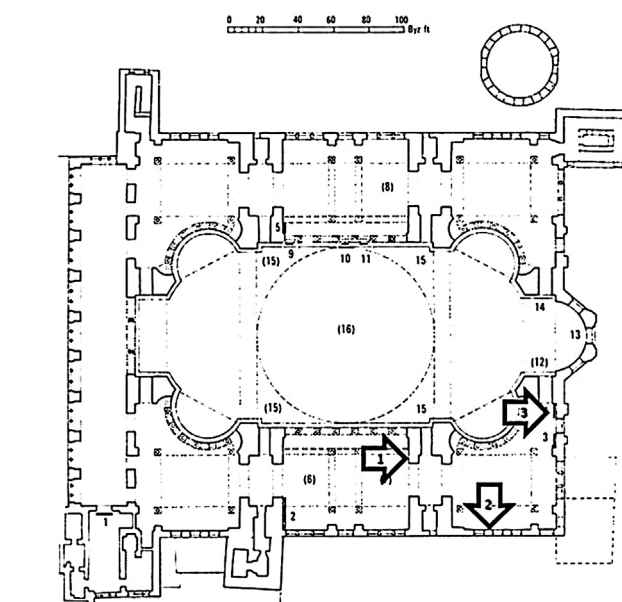


Fig. 1. Ground plan of Hagia Sophia at gallery level and above with areas under investigation [12].

- GPR: A ProEx system from MALÅ with 1.6 GHz and 2.3 GHz High Frequency (HF) antennas and Groundvision 2 software was used for data acquisition, whereas data processing took place using RadExplorer v.1.41;
- an infrared camera FLIR Thermo Cam B200, having a detector of focal plane array microbolometer in the spectral range of 7.5–13 μm , with thermal sensitivity of 0.08 $^{\circ}\text{C}$;
- fibre optics microscopy (FOM) i-scope – Moritex, was applied in several magnifications ($\times 30$, $\times 50$ and $\times 120$).

In addition the environmental parameters (Relative Humidity (%), Temperature ($^{\circ}\text{C}$)) were recorded during the measurements).

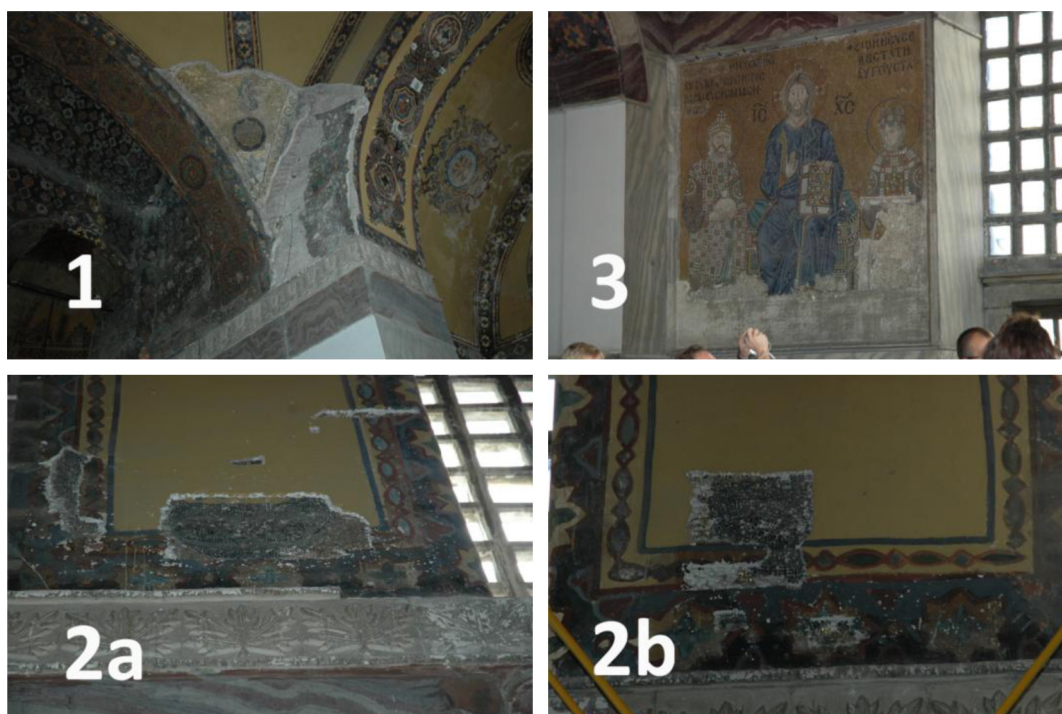


Fig. 2. Surfaces of investigation.

Download English Version:

<https://daneshyari.com/en/article/1038114>

Download Persian Version:

<https://daneshyari.com/article/1038114>

[Daneshyari.com](https://daneshyari.com)