

UNESCO

REPORT ON THE MISSION AT HAGIA SOPHIA (3rd visit)

Giorgio CROCI – Fritz WENZEL

1. Present at the meeting

With reference to the agreement between UNESCO and the Turkish Authorities. We have undertaken a mission to Hagia Sofia from 26th to 28th of January 2000.

- During the meeting we met the following people:

- *Ulku Izmiriligil (archaeologist/architect)*
Director of the Central Laboratory for Restoration and Conservation
- *Sabahattin Turkoglu (archaeologist)*
Director of Hagia Sophia Museum
- *Serdar Tugrul (engineer)*
Director of Surveying and Monuments of Istanbul
- *Prof. Dr. Mufit Yorulmaz (engineer/architect)*
Technical University of Istanbul
- *Prof. Dr. Zeynep Ahunbay (architect/restorer)*
Technical University of Istanbul, Head of the Department of Restoration, Director of Icomos Turkey
- *Prof. Dr. Mustafa Erdik (present only the 26)*
Bosphorus University, Department of Earthquake Engineering
- *Prof. Dr. Metin Ahunbay*
Technical University of Istanbul

2. The documentation

Hagia Sophia is one of the very few most important monuments in the world. Before starting with repairing and reinforcing measures in the sense of improving the structure and its safety it is necessary to collect and examine relevant documents which already exist in several countries, i.e. in the United States, in Great Britain, in Japan and, of course, in Turkey. Moreover we (the committee) have to decide on what is really necessary to know for assessing the safety of the construction as a whole and in detail.

From the collection of documents we will become aware what is already known about the structure and must not be investigated again. In this way we experience what is still unknown and has to be investigated within

the next time, i.e. the inner fabric of the main pillars, the crack pattern, which still has to be recorded, the origin of the huge deformations of parts of the cupola.

3. The strengthening project

Concerning the proposal of Professor Erdik to reinforce the crown regions of the main arches and the adjacent semidomes, first of all we declare that we do not want to express any evaluation before having discussed it with him; we could agree if it proves to be indispensable. To make a definitive decision it is necessary to have detailed information, especially regarding earthquake calculations together with the written report and the explanation of the kind of assumptions and calculation parameters. It will be also necessary to have sufficient knowledge on the material condition of the real existing building, in order to be able to see if these reinforcements could produce a transfer of high stresses in the adjacent zones, and, therefore, to create there, a risky situation. We think also that, if reinforcement should become necessary, it should be an integrated part of an improvement which concerns also other weak areas of the construction.

4. The four main pillars

All the present at the meeting agree that it is necessary to investigate the kind of masonry and the structure the main pillars are made of.

Presently only a few endoscopy analysis with drills that reach 1 m. but with photos taken only till 45 cm from the surface are available. These are not sufficient to understand what is inside considering that the section of the pillars is around 5 x 7,5 mt.

It has been suggested, therefore, to follow a program of investigation based on two subsequent steps:

- Radar analysis of the four pillars

If this kind of analysis is carried out by an experienced expert, the technique (non destructive) helps to obtain a first general evaluation of the inner structure and its weaker zones.

- Endoscopic analysis

This analysis will be carried out in the weaker zones indicated by the data acquired with the radar investigation.

The drill will be 2-3 mt deep in order to investigate the masonry till the core

5. Deformed zones of the dome

The dome presents large irregularities in the geometry of the intrados.

Part of these irregularities are certainly a consequence of the various collapses, having been impossible at the time of the partial reconstructions to recreate at the borders a continuous curvature between old and new structures.

We can't exclude however, on the basis of the present knowledge, that these irregularities or part of them have been produced throughout the centuries. We have then two possibilities: the first is that the

deformations are limited to the plaster which supports the mosaics; the second is that the deformations involve the structure, and that should represent a more serious problems.

Presently only four endoscopic analysis have been carried out on the dome, but they do not cross completely the section, so that they have been useful to indicate a material of poor quality, but they do not help to investigate the phenomenon.

We suggest therefore to organise a campaign of investigation (radar as well as endoscopic analysis) in the quarter of the dome, where presently the scaffolding stands. The investigations must cross the thickness of the dome (the average thickness of the vaults is 80 cm, and it is increased in the ribs) in order to detect:

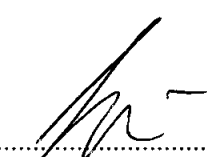
- if the plaster (usually covered with the mosaics) is detached from the structure and of which entirely;
- if the curvature that is visible on the intrados, which in some zones is completely lost and in others is even of the opposite sign, corresponds to a similar situation on the extrados; the evaluation could be done comparing the thickness measured in the deformed zones with the thickness in the zones of the dome that appears as "regular" (that is which follows the ideal form of the original undeformed zones).
- If in some zones of the extrados, to have a regular curvature on the roof, the deformation has been compensated with a fill.

6. *The survey*

It is necessary to have available the geometrical survey (including the data) carried out by the Japanese team. It is also suggested to complete the geometrical survey with a survey of the cracks, approximately indicating if they are old or recent, if they are large or narrow, and their extension.

7. *Thanks*

We want to express our gratitude to the Directors who have participated in the meeting for their kind hospitality.



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Prof. Ing. Giorgio Croci

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Prof. Dr.-Ing. Fritz Wenzel