



The restoration of the Galerius Palace in Thessaloniki

I. Papayianni

Aristotle University, Thessaloniki, Greece

F. Athanasiou, B. Malama, M. Miza, M. Sarantidou

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Abstract

The ensemble of the Palace of Galerius was built around 300 AD in the south east area of the city. It was political and religious center of Thessaloniki and consisted of Rotonda, the Arch of Galerius, the Octagonon and the Hippodrome.

The restoration project of the Palace has started from 1994 and is funded by the European Committee.

Two of the first in priority works of restoration are: The consolidation and protection of old masonries and the conservation of old floors which were covered by mosaics.

Before proceeding in the manufacture of the new repair mortars, a very systematic analysis of the old mortars and bricks was made to decide upon the chromatic hue, porosity and strength requirements of them. Then trial mixes for mortars and bricks were prepared and tested to find the final proportions of the mixtures. The study of the old materials and the designing of the repair mortars were made at the Aristotle University of Thessaloniki in the frame of NATO Science of Stability Programme GR-Restoration. It is planned the upper part of masonry to be elevated by adding a layer of brick and mortar. The floors with mosaics were recovered and depicted graphically. Their original design will be kept by applying colored mortars of the same hue based on lime, pozzolana and red or yellow brick dust.

History

The Palace complex of Galerius Maximianus was built about 305 AD to become the administrative and religious center of Roman



Thessaloniki [1]. The Rotonda, the Arch of Galerius, the Palace, the Octagon and the Hippodrome are its main buildings. The southeast part of the complex is still visible. It comprises large corridors, paved with mosaics and marble slabs, around a central atrium with colonnade that is surrounded by rectangular rooms. Along the east corridor four arched rooms are situated next to a large ceremonial hall with niche and mosaic floor. A monumental passage on the south led to the harbor of the Roman city. Founded on the spot of an older rectangular hall the Octagon is a majestic building, possibly a throne hall, richly decorated with colorful marble slabs and paving [2]. The date of its destruction is still unknown. According to certain scholars it was probably destroyed by an earthquake in 630 AD. The archaeological site of the palace was first discovered in 1939, during trial sections conducted by the Danish Archaeologist E. Dyggve. The systematic excavation began in 1950 by the Greek archaeologist Ch. Makaronas [3] and completed in 1971. In the spring 1994, the restoration works started again, according to a programme which will be continued until 1999, and is financed by the E.C. and the Greek State under the supervision of the 16th Ephoria of Prehistoric and Classic Antiquities.

Problems concerning the restoration of the Galerius Palace

The problem anticipated in the restoration of the archaeological site which is not now open to visitors has two branches: One and the most urgent is the maintenance and protection of the remains and the other has to do with the management and upgrading of the site so as to be properly embodied as a functioning part in the center of a developing modern city.

The first problem could mainly focus on the conservation of old masonries and old floors with mosaics.

The present bad condition of the monument is due to the fact that for the last twenty five years it was exposed to weathering effects without taking any measure for its conservation. The only intervention after the excavation for their maintenance was a small scale consolidation treatment during 1969-1970. This led to the decay of bricks and mortars and destruction of valuable mosaics of

old floors. Most of excellent quality plasters with which vertical marble slabs were retained on the walls, decorating them, were detached and lost. The symptoms of pathology are very intense. Efflorescence salts cover the external surface of bricks and mortars. On the deteriorated wall surfaces there are cracks fissures and mould. The mortar of masonry joints has softened and removed and deep pointing is urgently required.

The old masonries of the Palace

Description

The masonry type that dominates at the Galerious Complex is the opus mixtum which is so characteristic in late Roman period buildings. The walls are constructed from successive zones of rough stones and bricks with a strong mortar as binding material. The masonry structure and alignment present several defects which are covered by a thick layer plaster coating. The stones used, came from the local green stone quarries located near the old Roman city. The height of the stone zones ranges from 0.80 cm (octagonal) to 1.20 cm (basilica) whereas the brick zones consist of four or five layers of bricks. The buttresses, the doorposts and the wall corners are built exclusively with bricks.

The old materials of the masonry

The bricks used present a great variety in dimensions, colour and texture. They come from different workshops and possibly many of them are in second use. The sealings and imprints on their surfaces provide very useful pieces of information for the chronology and identification of the historical phases of the buildings. Usually the under surface of them is rougher than the upper one. The brick thickness ranges from 3 to 4 cm. The characteristics of the original bricks are give on Table 1 [4].

The structural mortars could be classified into three categories based on their characteristics [5]. They are of great thickness usually from 3.5 up to 6.0 cm. Especially in stone parts of masonry the mortar fill the space among the stones. The first and second category are of



white-grey colour and contain a reactive argillaceous material to which could be attributed their relatively high strength level. This material is like pozzolana whose reactive silica content is very low. The mortars of those categories present differences in proportions of their main constituents and in strength but it is obvious that the materials and technique followed for their manufacture is the same.

Its worth mentioning that they present similarities with the authentic roman mortars of Ach of Galerius. They contain crushed bricks as aggregates but not brick powder as binder. The clayey material found in them was added to lime unburn for their manufacture. The mortars of third category are of white pink colour and are of lower strength compared with those of I and II categories. They contain brick powder as binding agent. These samples were from north and north-west masonries of the Palace. The characteristics of old structural mortars are given in Table 2.

The plasters present a characteristic pink tint due to the crushed brick which was added to the lime and pozzolana mixture. The purpose of this addition was to increase their resistance to humidity. The mortars are of great thickness (up to 5 cm) and usually were laid in two or three layers. Each of them differs from the other in granulometry. In the first layer the fine grained material (sand) is of greater amount while in the middle ones, the sand is coarser and crushed brick (4-10 mm) aggregates were also used. These aggregates present very good cohesion to the binding mortar.

The consolidation and conservation of old mortars

For the protection of the old masonries, the bedding of a discernible protective layer on their upper part was decided. The composition of the mortar of this layer was based on the analysis of the original structural mortars, taken from the remains of old masonries. A few existing cracks will be filled with a grout based on a lime and pozzolana mixture. To decide upon the proportioning of the mortars for pointings a few trial compositions were prepared. The composition that satisfies the criteria of compatibility with the characteristics of old mortar was based on lime and pozzolana and presented 7.0 Mpa strength at 3-month age and 16-17% porosity. The data from the analysis of the old mortar are given in Table 3.

**Characteristics of old bricks of Galerius Palace**

| Dimensions (cm) | | | Apparent Spec. Gravity | Absorption % | Strength kg/cm ² | Colour |
|-----------------|-------|-----------|---------------------------|-----------------|--------------------------------|----------------------|
| Length | Width | Thickness | | | | |
| 40 | 30 | 4.5 | 1.70-1.80 | 16-18 | 235-315 | red- brown yellow |

Visual observations: grooves on the upper surface of bricks - bulges - concentration of salts
 Visual observations: max size < 2mm - cracks < 1mm - fine aggregates - rich in clayey powder - good bond

| Dimensions (cm) | | | Apparent Spec. Gravity | Absorption % | Strength kg/cm ² | Colour |
|-----------------|-------|-----------|---------------------------|-----------------|--------------------------------|--------------------|
| Length | Width | Thickness | | | | |
| 40 | 30 | 3-3.5 | 1.67-1.85 | 12.5-14.5 | 85-110 | Light red brown |

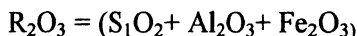
Visual observations: grooves of different shapes on the upper surface - coarse aggregates
 Visual observations: max size < 2mm - cracks < 1mm - salts in pores - good bond with mortar

**Characteristics of old structural mortars of the Galerius Palace**

| Colour | Constituents | Apparent specific gravity | Porosity % | Gradation | Compressive strength (crushing value kg/cm ²) |
|------------|---|---------------------------|------------|--|---|
| white-grey | Total R ₂ O ₃ * 26-28% Solude R ₂ O ₃ * 2-3% Total CaO 35-40% Solyble CaO 34-38% | 1.6-1.65 | 18-20% | finer 80-90% (0-4mm) Coarse aggregates 20-10% (6-16mm) | 35-40 |
| white-grey | Total R ₂ O ₃ * 40-45% Solude R ₂ O ₃ * 2.5-3.0% Total CaO 25-30% Solyble CaO 25-27% | 1.7-1.75 | 16-17% | finer 70-80% (0-6mm) Coarse aggregates 30-20% (6-16mm) gradation curve: even | 25-40 |

**Characteristics of old structural mortars of the Galerius Palace (continued)**

| Colour | Constituents | Apparent specific gravity | Porosity % | Gradation | Compressive strength (crushing value) kg/cm ² |
|------------|--|---------------------------|------------|--|--|
| white-pink | Total R ₂ O ₃ * 35-40% Soluble R ₂ O ₃ * 2.5-3.0% Total CaO 30-32% Soluble CaO 29-30% | 1.68-1.72 | 17-19% | fines 75-80% (0-6mm) Coarse aggregates 25-20% (6-16mm) gradation curve: even | 20-30 |



* Microscopical observations by stereoscope (enclosed materials)

Mortar Category I : few grains of crushed bricks (4-6 mm)- grains of carbon concentrations of calcite-chips of wood-very good bond between crushed brick and paste-cracks in the paste

Mortar Category II : grains of crushed brick (4-16 mm)-concentrations of calcite-chips of wood-grains of carbon-cracks around aggregates-crystals of salt grade of deterioration is more intense than I

Mortar Category III: grains of crushed brick up to 19 mm-crystals of sulfate salts

**Composition and characteristics of repair mortars****Raw materials (by weight)**

| Cement putty (in water) | Ground Santorine Earth | Brick Powder | Cement | Sand | Gravel | Crushed Br | |
|---|------------------------------|--------------------------------------|----------|------|-------------|------------|-----|
| | | | | | | (4-6)mm | (4- |
| 1 | 1 | - | 0.2 | 3.6 | 1.12 | 1.12 | |
| 1 | 1 | - | 0.5 | 4.5 | 1.5 | 1 | |
| 1 | 1 | 0.5 | 0.5 | 3.0 | 2.0 | 1.0 | |
| Compressive strength kg/cm ² | | Flexural strength kg/cm ² | | | Porosity % | | |
| 7-days | 3-months | 28-days | 3-months | | at 3-months | | |
| 1.7 | - | 10.5 | - | | 19 | (28-d) | |
| 9.2 | 79.5 | | 16.64 | | 18 | | |
| 8.6 | 78.5 | 13.2 | 17.3 | | 16-18 | | |

Characteristics of old mortars taken from the floors of the Galerius Palace

| % | Compressive strength kg/cm ² | Porosity % | Apparent Spec. Gravity |
|------|---|------------|------------------------|
| 31 | 25-30 | 17-19 | 1.65-1.70 |
| 1.22 | | | |
| 40 | | | |
| 27 | | | |

For the reconstruction and elevation of a part of masonry the bricks required, should have similar mechanical and functional characteristics with the original ones. For this purpose bricks were specially manufactured and checked according to guidelines given by Lab of Building Materials in the frame of the NATO Science for Stability Programme, GR-Restoration.

These characteristics were:

- Colour similar to that of the originals
- Dimensions and surface similar to originals
- Strength of the same level with the sound bricks of old masonry
- Porosity similar to that of old mortars
- Low Absorption of Capillary Elevated Water

In cooperation with the manufacturer we looked for the appropriate clays which should have a low content in phyllosilicates. It was also tried air entrainer to be used in order the capillary water rise to be reduced. The application of guidelines given, led to satisfactory result.

The old floors of the Galerius Palace

Description

The atrium on its four sides, is surrounded by large corridors paved with mosaic floors.

The excavation of the north corridor was first conducted in 1963. It was then revealed a part of the mosaic floor. The mosaic floor was originally covering an area 68x8,5 m, which is the total area of the corridor. Today only parts of it are preserved all over the area. It comprises three sections each one with different geometric patterns. A band with chess separates them. In the first section from E to W the geometric pattern is a rectangular with an adjacent zone of pliant branches and ivy leaves on its one side. Its central pattern savores, lozenges and triangles. In the second section there are four octagons centrally located. They are surrounded by six-sided and between them there are twisted quilloche forming meanders. The whole pattern is framed by a meander band. In the third section the subject is the double star-shaped meander which, like a continuous pattern, fills the whole section. Between the bands of meanders there are



savares and lozenges. The mosaic is made of marble white, black, red, brownish-red, bluish-grey tesserae. The polychromy lends brightness to the composition.

Pathology

The present situation of mosaics is bad. The construction, during the ancient times, of a drainage system which runs along the whole length of the corridor and the subside of the ground due to the soil consistence resulted in cracking and disintegration of the mosaics. The mortar that connected the pebbles together was removed because of weathering. The mosaic fragments of north-west floors were scattered and lost. It seems that the red-brown and blew-grey grains of mosaics suffer more from exfoliation than those of red colour. Because the decay of the mortar of the mosaic substrate the pebbles are easily detached in many parts of mosaic floor while in other parts intense biological activity (algae, fungi) has caused serious damage. Since the archaeological site is open, the gathering and stagnating rainwaters during the months of winter contributes to further softening of mortar and destruction of mosaics. That is why their preservation and restoration is urgent.

Proposal for restoration

The preservation of old mosaic floors and their restoration was one of the most delicate and complicate interventions.

Much preliminary work was needed for filling and compacting the existing in the area excavations and improving the ground on which the new floors will be placed.

Measurements also of water retentivity of the soil layers were made in order to be taken into account in designing the bedding mortars.

According to approved restoration study the authentic mosaic parts of old floors will be detached and replaced on a new substratum.

The level and inclines of it will be arranged according to the existing original ones (0.8% from E→W and 0.7% from N→S) which were defined by studing the level of existing wall-bases, marble pillar bases located at the south-east part of wall of the corridor. It is proposed the re-integration of the lacunae existing in the geometric

patterns of reconstruction drawing. The old fragments of the mosaic will be visually unified by gapfilling and rendering the continuation of the geometrical design in such an abstract mode that although the decoration details will be omitted, the background colours would echo the original ones.

In more details the programmized work is:

The layer of substratum on which the tesserae will be put will be repaired with concrete made with lime and pozzolana. The mixing design of it will be based on the analysis of mortar samples taken from different sections made on the existing old substratum (Table 4). Special care will be given to colour nuance and increase of resistance to weathering.

On this new substratum thinner layers of coloured mortars (dark grey, redish and yellowish) will be placed according to restoration design.

An effort is made the colour of these mortars simulating the old ones to be achieved by using coloured traditional binder such as grey pozzolana, red and yellow brick dust.

References

1. Petsos F., "The Galerius Palace in Thessaloniki" Archaeological Deltion 21, Chronica 1966
2. Dyggve E., "Researches sur le Palais Imperiale Thessalonique", Studia Orientalia, 1933
3. Makaronas Ch., "The Octagon of Thessaloniki", P.A.E., 1950
4. Papayianni I., Stefanidou M., "Microstructure and Mechanical Proceedings of the Int. Workshop on Materials for the Consolidation and Restoration of Monuments", Thessaloniki, Sept. 19, 1995
5. Papayianni I. Tsolaki A., "Microstructure and Mechanical Strength of Ancient Mortars for Consolidation and Restoration of Monuments and Historical Buildings", Thessaloniki, September 19, 1995