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THE RESTORATION OF THE HELLENISTIC FOUNTAIN OF SAGALASSOS IN TURKEY

Teresa Cristina Patrício

Resumo

O Raymond Lemaire International Centre for Conservation da Universidade Católica de Lovaina na Bélgica colaborou com a missão arqueológica de Sagalassos para a investigação arquitetónica e estrutural e para a preparação do projeto de restauro das ruínas da casa-fonte de estilo Helenístico tardio. As escavações arqueológicas em Sagalassos, dirigidas pelo Prof. Marc Walkens do departamento de arqueologia da Universidade Católica de Lovaina, começaram em 1990. As ruínas da casa-fonte Helenística – Nymphaeum -, do século I a.C. e destruídas por um tremor-de-terra no século VI d.C., encontravam-se completamente enterradas em depósitos erosivos das montanhas. O edifício, encastrado no declive do terreno tem uma planta retangular de 10,90 metros de largura por 7,33 metros de profundidade e é orientado a sul. O edifício é composto por três pórticos Dóricos desenhando um plano em forma de U. Os pórticos são compostos de oito meias colunas adossadas a pilares retangulares e em pilares duplos de canto, estabelecendo a partição do espaço em nove partes. As colunas estão pousadas em pedestais que compõem um parapeito desenhando as bacias de colecta de água. O entablamento é composto por arquitraves e frisos unificados. As cornijas elaboram a cobertura das bacias. A estrutura é inteiramente construída em blocos talhados em pedra calcária e aparelhados em junta seca.

O projeto de restauro utilizando técnicas de anastilose foi proposto para a estrutura de pedra do Nymphaeum Helenístico. Os trabalhos desenvolveram-se em quatro fases: 1ª Fase – escavações, recolha de informação e documentação do material descoberto. 2ª Fase – anastilose teórica de fragmentos e blocos. Estudos, experiências e testes no terreno foram executados de modo a desenvolver um conhecimento aprofundado da estrutura original, dos sistemas construtivos, dos sistemas de talha da pedra, das técnicas de montagem, etc. 3ª Fase – estudo do posicionamento exato dos diferentes blocos na estrutura, reconstituições gráficas. Restauro de fragmentos e blocos e consolidação das ruínas in-situ. 4ª Fase – anastilose final e reconstituição do edifício através do reposicionamento dos blocos de pedra restaurados nas suas posições de origem e exercendo as suas funções estruturais respetivas. O restauro formal, estrutural e funcional do Nymphaeum Helenístico tardio terminou a 3 de setembro de 1997.

O presente artigo apresenta os princípios orientadores na escolha das diferentes técnicas de restauro utilizadas, e os resultados obtidos. O sistema inovador desenvolvido para o restauro dos diferentes blocos de pedra da estrutura do Nymphaeum – um sistema 'Fibra-de-vidro/ resina epoxídica/pó de pedra' – dá uma resposta efetiva aos princípios de 'intervenção mínima', 'compatibilidade de materiais' e 'retrocessividade'. O sistema utilizado – 'Fibra-de-vidro/resina epoxídica/pó de pedra' – pretende: juntar e integrar fragmentos que compõem um só bloco transformando fragmentos de pedra em blocos monolíticos estáveis; estabelecer ligações verticais e horizontais entre blocos, quando posicionados na estrutura, mais fracas que a pedra. Com este tipo

de sistema pretende-se evitar ligações verticais e horizontais rígidas, o que causaria a destruição completa dos blocos, em caso de um tremor de terra de grande magnitude. A retrocessividade do sistema é garantida palas dimensões e proporções aplicadas.

As ações do projeto de anastilose seguiram a vocação da ruína, preservando o monumento, reconstituindo a sua forma física, restabelecendo o comportamento estrutural de cada elemento e recuperando a função original de fonte. O Nymphaeum hoje, é uma ruína, onde o restauro da função e da estrutura criam uma permanente cenografia dependendo do dia e da hora, criando um jogo de transparência, cheio e vazio, luz e sombra, som e silêncio.

Introduction

The R.Lemaire International Centre for Conservation of the K.U.Leuven was involved in the architectural and structural *Bauforshung* of the remains of the Late Hellenistic Nymphaeum on the archaeological site of Sagalassos (Patrício [et al.] 1993; Patrício [et al.] 1995), as well as in its restoration (Van Balen [et al.] 1995, Ercan [et al.] 1997, Patrício [et al.] 2000).

Archaeological excavations in Sagalassos started in 1990 under the direction of Prof. Marc Waelkens from the Department of Archaeology of the K.U.Leuven, Belgium. When the excavations started, the remains of the Nymphaeum dated from the 1st century B.C., were almost completely buried under slop deposits from the mountains. During the excavations, a relatively well preserved fountain house came to daylight (Waelkens [et al.] 1991, Waelkens [et al.] 1993, Waelkens [et al.] 1995). The rectangular building, 10.90 m wide and 7.33 m deep, orientated to the south is set into the mountains slope. It is constructed in limestone carved blocks in a regular polygonal dry masonry arrangement. The fountain is composed by three Doric porticoes in a U-shaped lay-out. The porticoes are composed of eight half-columns attached to a rectangular pillar and to corner pillars, thus establishing the partition of the space into nine parts. These supports stand on the parapet of the water basin. The parapet projects forward below each column to resemble a pedestal. The entablature is made up of architraves and friezes together with their cornices. The cornices make the roof of the water basins (Patrício [et al.] 1995).

To restore a ruin obliges to the elaboration of a preliminary program based on the values assessment of the remains and their cultural significance for the site and for the region. During the excavating, it was realised that the structure of the fountain house, a structure made by carved stone with dry joints from the late Hellenistic period - a common and everyday building in its times - was presenting an inestimable value: nearly all of the architectural elements were present in the area of the building (Figure 2) and presenting a good state of conservation together with the in-situ remains (Patrício [et al.] 1995). The aim of the project follows the vocation of the ruin: preserving the monument by its physical restitution, re-establishing it's initial and nowadays missing volumes by reusing all its original architectural elements and placing them into their original positions. (Figure 3, Figure 4) The integrity recovered and its beauty suggested while preserving the original structural behaviour of each architectural element. Besides, as the natural water spring still exists, the final physical restitution aimed above all to recover the original Nymphaeum vocation by restoring its original function of a fountain.

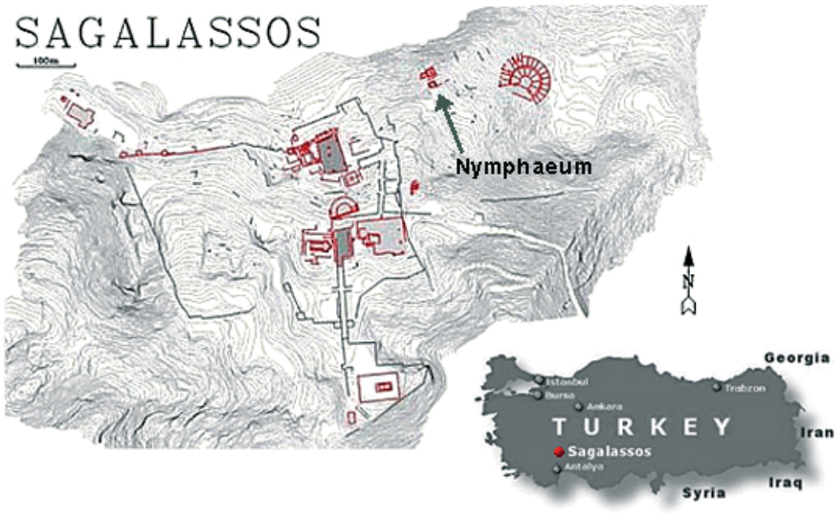

Figure 1 – Site plan

Figure 2 – General view during the excavations, July 1992.

Figure 3 – General view before the restoration works, August 1993.

Figure 4 – General view after the restoration woks, September 1997.

After the preliminary works and excavations at the *Nymphaeum*, a restoration project applying *anastylosis* techniques was proposed for the stone structure of the Late Hellenistic *Nymphaeum*. The first phase of the work, from 1991 to 1992, included gathering information and preparing the discovered material for further restoration (Patrício [et al.] 1993). The second phase began in 1993 and led to partial *anastylosis* of some parts of the building with the partial *anastylosis* of fragments and blocks. A preliminary study of the architectural elements in 1992 also allowed the first experiments and tests during the campaign of 1993, as well as a detailed study by means of direct investigation. It was possible, as a result, to establish relationships among fragments, to determine the general shape of the building, (Figure 5, Figure 6) as well as to define the construction techniques, the stone carving process, lifting techniques, surface treatment, etc. The third phase began in 1994. Research focused on the position in which the stones were found at the time of excavation and on their relation with the structure. Graphic restitutions were established (Figure 6, Figure 7, Figure 8). The architectural elements were restored (Ercan [et al.] 1997; Patrício [et al.] 1997). During the campaign of 1995, 1996 and 1997, the final *anastylosis* and reinstatement of the monument reusing the original and restored architectural elements was realised. The restoration project of the Late Hellenistic *Nymphaeum* by its formal, structural and functional restitution was completed the 3rd September 1997. (Figure 2, Figure 3, Figure 4)

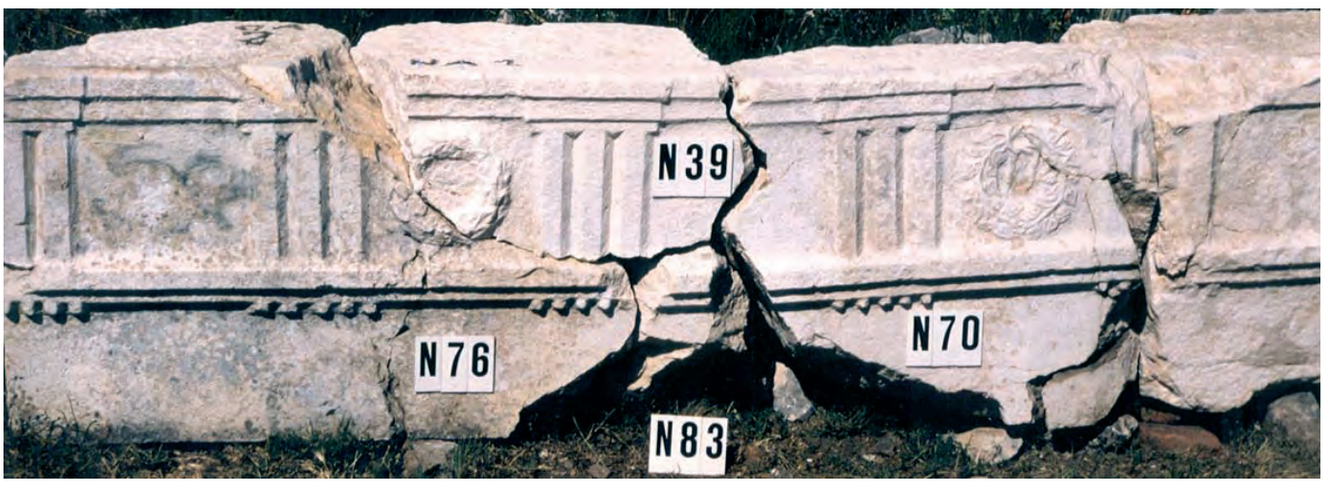

Figure 5 – Trial of fragments composing an architrave.

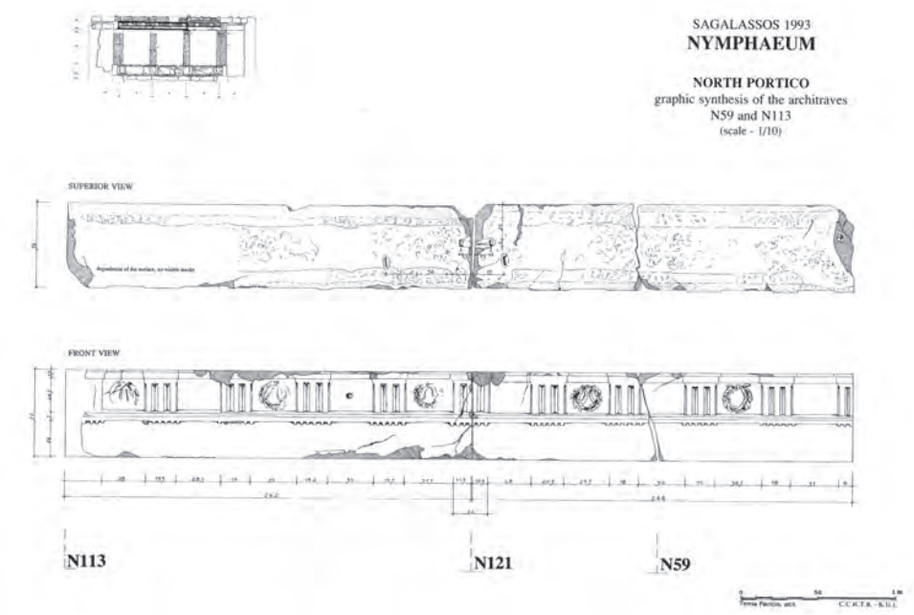

Figure 6 – Graphic synthesis of two architraves of the North Portico.

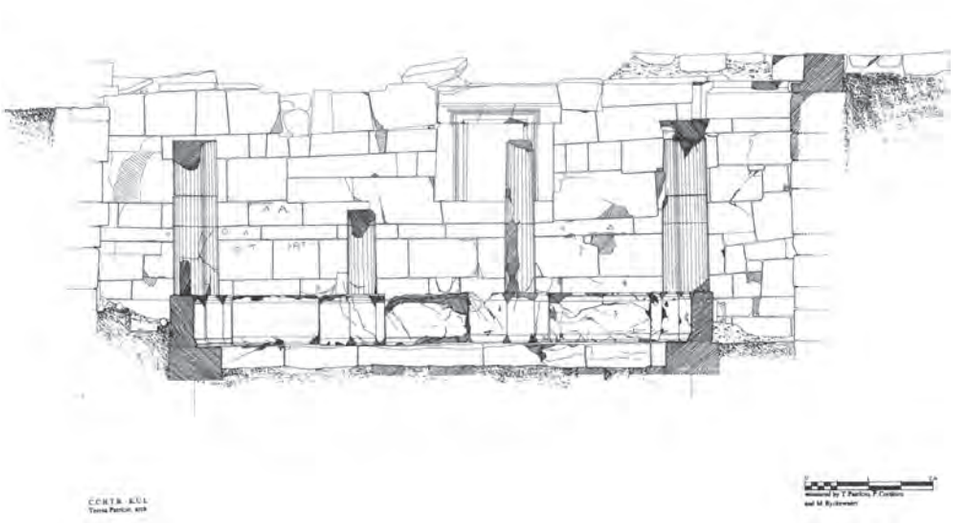

Figure 7 – Graphic survey of the north portico.

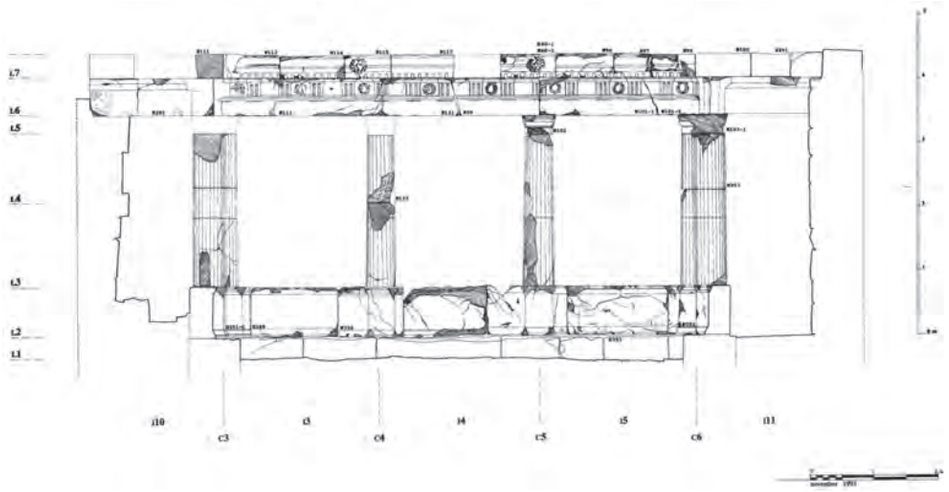

Figure 8 – Graphic synthesis of the north portico.

Requirements and principles for the intervention

From the generally accepted Venice Charter and current discussions on the guidelines for monuments restoration, and especially within the framework of archaeological sites, a number of requirements and principles were established and taken into account in every project decisions in the international world of monuments restoration. Therefore for the drawing up of the restoration project of the late Hellenistic *Nymphaeum* and for the choices of the various restoration methods it was essential to define several principals to be used as project guidelines. They can be summarised in the following topics: restitution, authenticity, reversibility, compatibility and retreatability.

The respect and preservation of the original material was our premise to decide the type of restoration to be applied to the Nymphaeum. The choice of the restoration techniques was based on the principle of a minimum intervention. If the main goal was to preserve its integrity, with the respect to the original materials the idea of a reconstruction - *new construction of a structure and use of new materials* - was out of priori. Only a restitution - *to reinstate a structure with its original materials* - could promote correctly the intentions.

The authenticity of the ruins of the *Nymphaeum* revealed through the excavations should be understood as different levels of significance. Apart from the authenticity of the materials - which is easily understood as being the original building material and architectural elements - the original structural system, destroyed by an earthquake, also represents a 'state of understanding' regarding the construction of fountains houses built as trabeated structures. The latter means that there is some added value in reassembling the structure as it was originally, instead of creating a new structure which would 'carry' the architectural elements of the *Nymphaeum*. The design of the intervention aimed to protect the original elements of the structure, rather than just its architectural appearance. (Ercan [et al.] 1997, Patrício [et al.] 2000)

Reversibility is a term that has often been used in the conservation of historical heritage. At the end of the 20th century this principle was very much applied to architectural restoration. An international group of experts came recently to the conclusion that: "*...Along with minimum intervention, the concept of reversibility has been considered to be one of the principal requirements of conservation treatments. However, in the case of the treatment under discussion, reversibility is often not achievable and in some instances not applicable. Prompted by the suggestion made by Sasse and Snethlage as well as discussions which have long taken place in the field, it was proposed that the requirements of reversibility be replaced by the demand for compatibility and retreatability...*" (Teutonico [et al.] 1997).

Simply stated, 'compatibility' means that introduced treatment materials will not have negative consequences while 'retreatability' means that the conservation treatment in the present would not prevent or impede further treatment in the future. While in the context of the discussion about reversibility mentioned above was mainly in reference to surface treatments, these criteria also apply to the treatment carried out on the *Nymphaeum*. In the context of a structural treatment in an earthquake risk-area, this can be translated into the idea that an earthquake should not create more damage than damage created by previous earthquakes. It also means that if a next earthquake would damage the *Nymphaeum* structure as in the past, the types of treatments proposed for the restoration should at least remain re-executable.

Restoration of the stone structure - Field Work

The field works at the *Nymphaeum* concentrate on the following: archaeological research, architectural investigation (detailed survey of the *membra disjecta* and *in-situ* remains) (Figure 5, Figure 6), restoration of the stone carved blocks (*membra disjecta* and *in-situ* remains), replacement of missing parts of the structure, consolidation and levelling of the foundations, correction of the west wall's distortion, controlling and canalising the natural water spring with testing of mortars for the water basins and final anastylosis of the structure.

The first problem to solve for the re-erection of the dismembered building was to make up sound blocks, as strong as they had been originally. Broken fragments had to be joined together and where parts of the blocks were missing they needed to be completed for structural integrity. The materials and techniques, after being studied and improved through laboratory tests were then applied for the restoration of the fountain house. (Ercan [et al.] 1997) The restoration of the stone blocks can be divided into four main activities: joining the broken parts, completing the missing parts consolidation and cleaning of the blocks.

Joining of the broken stone blocks

An epoxy-based adhesive mixed with a limestone powder filler was used to glue small fragments. By mixing the epoxy adhesive with an inert filler of powdered limestone the strength of the adhesion and cohesion has been reduced to almost the strength of the stone itself.

For joining the structurally important broken blocks, such as columns drums, architraves and cornices, fibreglass rods were used together with the epoxy adhesive. Two conditions were imposed on this work. First, the broken blocks should be joined in such a way that the strength of the joined block would not exceed the limit state strength of the monolithic block. Second, if the joined block were to break, it should break again in the original failure. To fulfil these requirements, the application area of the epoxy glue was limited to only half of the broken surface and the Fiberglas reinforcing rods were designed appropriately according to these considerations. The brittle nature of the fibreglass is an advantage here, as it means that the reconstruction can be altered at any time in the future, as the broken reinforcement can be removed and replaced by a similar system. The number, size and length of the reinforcing rods varied according to the broken parts of the block and its structural function. For the blocks under flexural stress, like architraves and cornices, the rods should have a certain anchorage length, so that they would not be pulled out. Generally 4 fibreglass rods of 34 cm length and 16 mm diameter were used for joining these blocks (Figure 8). Shorter rods are sufficient for joining the column drums, as the main structural stress on them would be in shear. Generally 4 fibreglass rods of 20 cm length and 12 mm diameter were used to join the columns drums.

Figure 9 – For joining the architraves, fibreglass rods were used together with the epoxy adhesive.

Completing the Missing parts of the Stone Blocks

After joining the fragments composing a block, missing parts had to be completed to fulfil the structural integrity. An epoxy mortar obtained by mixing epoxy adhesive with well-graded crushed limestone filler was used for this purpose. The maximum particle size of the filler was 2 mm and the binder to filler ratio of the mortar varied in between 1:5 to 1:8 by volume, according to the application. The epoxy mortar, which was tested earlier in the laboratory, has similar physical properties to the original stone. Its mechanical properties are slightly weaker than the original stone and it also has a more elastic behaviour than the stone.

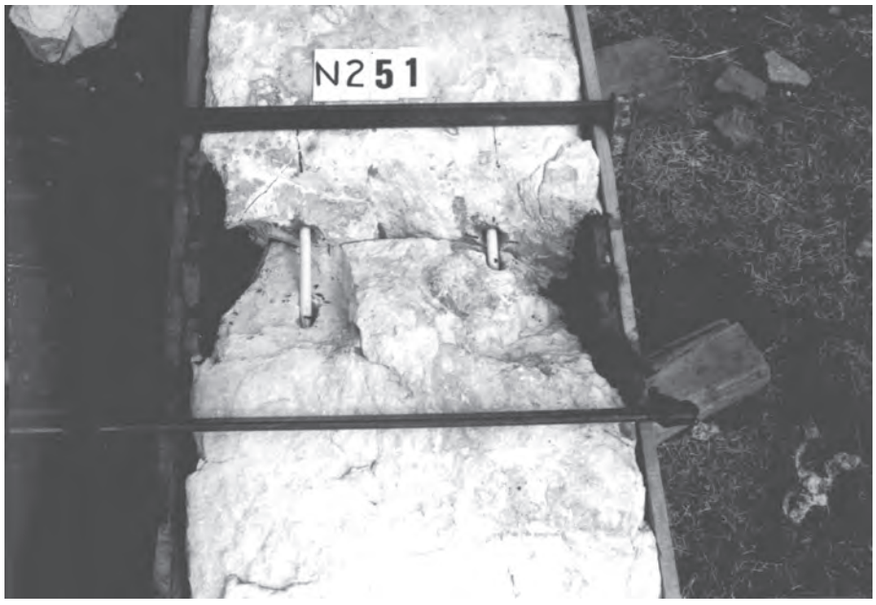

Figure 10 – View of a joined cornice block, before the missing parts were completed.
The fibreglass rods used for joining the two fragments are visible.

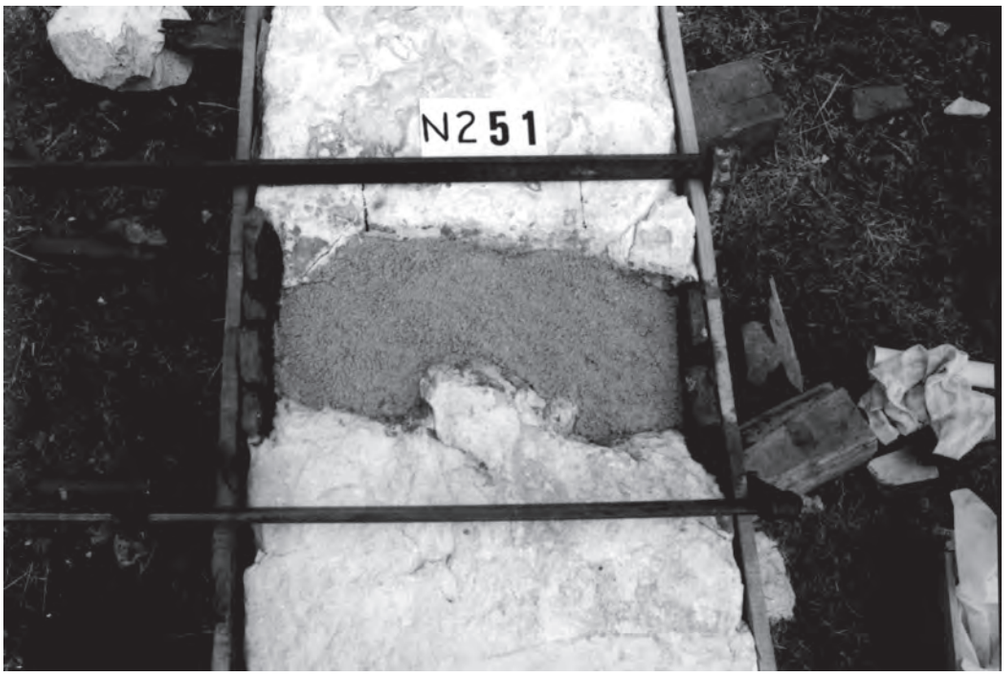

Figure 11 – View of the cornice block after its missing parts were completed by an epoxy mortar. The epoxy mortar will then be covered by the final covering mortar.

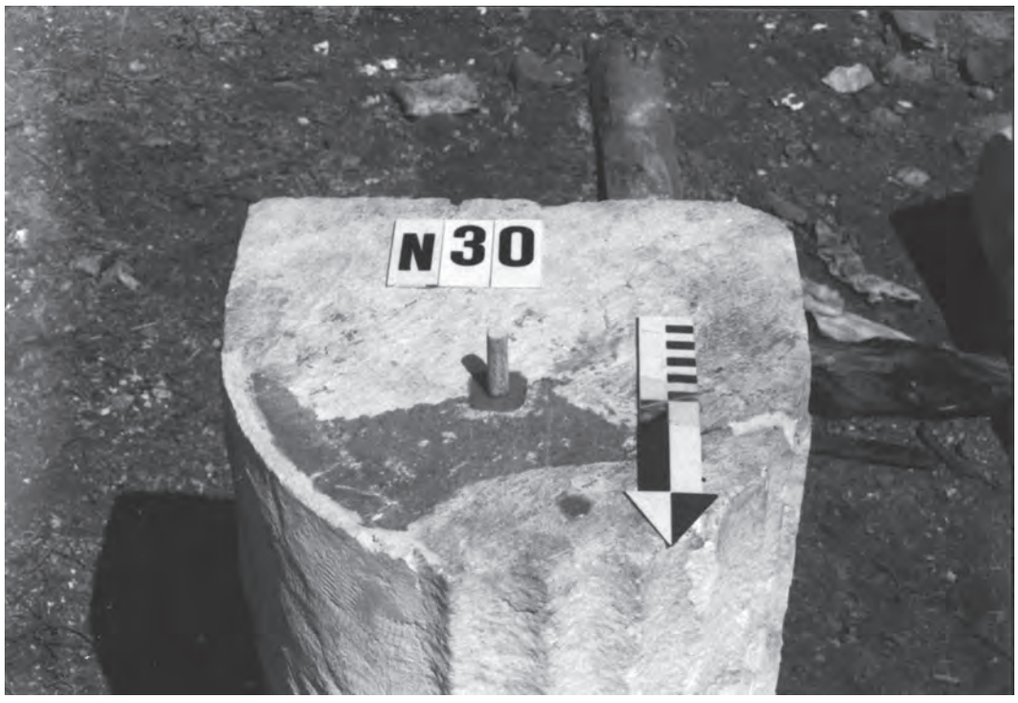

Figure 12 – View of a restored column drum. The filling and the covering mortar are visible as well as the fibreglass rod for the vertical connexion of the drum.

The epoxy mortar was applied in a few layers, where each layer was compacted firmly. According to the volume to fill and the structural function of the block to be completed, fibreglass bars were sometimes used for a stronger bond between the epoxy mortar and the stone blocks (Figure 10, Figure 11). As epoxy mortars discolour under ultraviolet radiation and in order to create a proper surface texture, a 1 to 2 cm thick covering mortar was applied over the dried epoxy fillings (Figure 12). The covering mortar was a zinc chloride-based mineral mortar, which was also tested in laboratory before being used. This quick setting and non-shrinking covering mortar has a very similar colour to the stone and its shape and textures can be finished easily by carving (Figure 15).

Structural consolidation of the Stone Slocks

Structural consolidation was necessary for stone blocks of structural importance that had severe cracks. First the stones were detected by inspection and sound testing, then structural consolidation was undertaken where necessary by pinning fibreglass rods, anchored by an epoxy grout, through the cracks. Fibreglass rods of 7 mm and 8 mm diameter and at least 20 cm length were used. Some of the in-situ blocks were also consolidated in-situ using the pinning method.

Non-structural consolidation

The fissured and flaking stone blocks of no structural importance were consolidated *in-situ* by injection of water-porous glue. Different materials were tested and evaluated for this purpose. The most important criterion was that the sealed crack should allow water vapour through, so that the wet and very fine sand present in the crack could dry, in this way frost damage due to the expansion of the water trapped in the crack is avoided. After these consolidations, all the fissures and cracks were sealed with a zinc chloride-based covering mortar, to avoid water seeping in, which could cause further frost damage.

Cleaning of the blocks

All the restored blocks were cleaned with cold water under pressure (100 to 200 bars). A chemical cleaning method was applied to the biological dirt deposits that did not come off with water. A cleaning product "complexion paste" was used for this. The pasta was applied on the stone surface with a brush and was covered with a plastic cling-film to prevent drying out. After two days the paste was washed away with water under pressure. The cleaning product, which does not leave or generate harmful salts on the stone, was tested earlier in laboratory. The final cleaning was done after putting the blocks in place.

Replacement of missing parts of the building

The architectural investigation of the fountain house revealed that some complete stone blocks from the original structure were missing: wall blocks from the south and west wall, steps blocks from the entrance stair, cornices and capitals. Since the start of the project, the principle of minimum intervention was a fundamental aspect in our philosophy. Following this principle, it was clear that the missing blocks were only replaced by new elements when it was strictly necessary for the positioning of an existing one (Figure 17, Figure 18). (Patrício [et al.] 2000: 408)

Figure 13 – Preparing a new carved capital for the insertion of the existing fragments from the original capital.

Figure 14 – Insertion of original fragments in a new carved capital.

For the replacement of the missing blocks by new elements two problems arose: The determination of the shape and proportions of the missing element and the choice of the material to produce them. From the study of the existing material it was easy to extrapolate the shape and dimensions of the missing elements. Nowadays, different materials are being used in various restorations all over the Mediterranean area, such as artificial stone, concrete and stone. For structural reasons the missing parts should be on a material with physical and mechanical properties similar to the original parts of the structure. It was decided to prepare new wall blocks, stairs steps and capitals by carving natural stone, from a quarry in the region and with similar

geological properties. This material is not expensive in Turkey and being a similar material to the original allowed us to remain faithful to the materials, construction techniques and structural behaviour of the ancient building.

Furthermore, the use of natural stone cannot harm the building, its long-term durability is known and it is highly compatible with the original material from an aesthetic and structural point of view. (Patrício [et al.] 1997, Patrício [et al.] 2000) As the main goal of the project was to preserve the original material it was decided to integrate all the small capitals fragments found into the new carved blocks (Figure 13, Figure 14). To improve the aesthetic integration, the final shades and decorations of the new carved stones, as well as matching the integrated original fragments, were further finished when the new blocks were in their final position on the structure (Figure 15, Figure 16). The final surface carving was integrated into the ancient one to guarantee a more satisfactory aesthetic result without constituting a violation of the principle that the modern parts should remain distinguishable from the older ones (Venice Charter: 1964).

Figure 15 – The original small fragments integrated into the new carved blocks.
The final decorations as well as matching the integrated original fragments were further finished.

Figure 16 – Final surface carving of the integrations after their final anastylosis.

Figure 17 – First level of anastylosis, without introducing new carved elements.

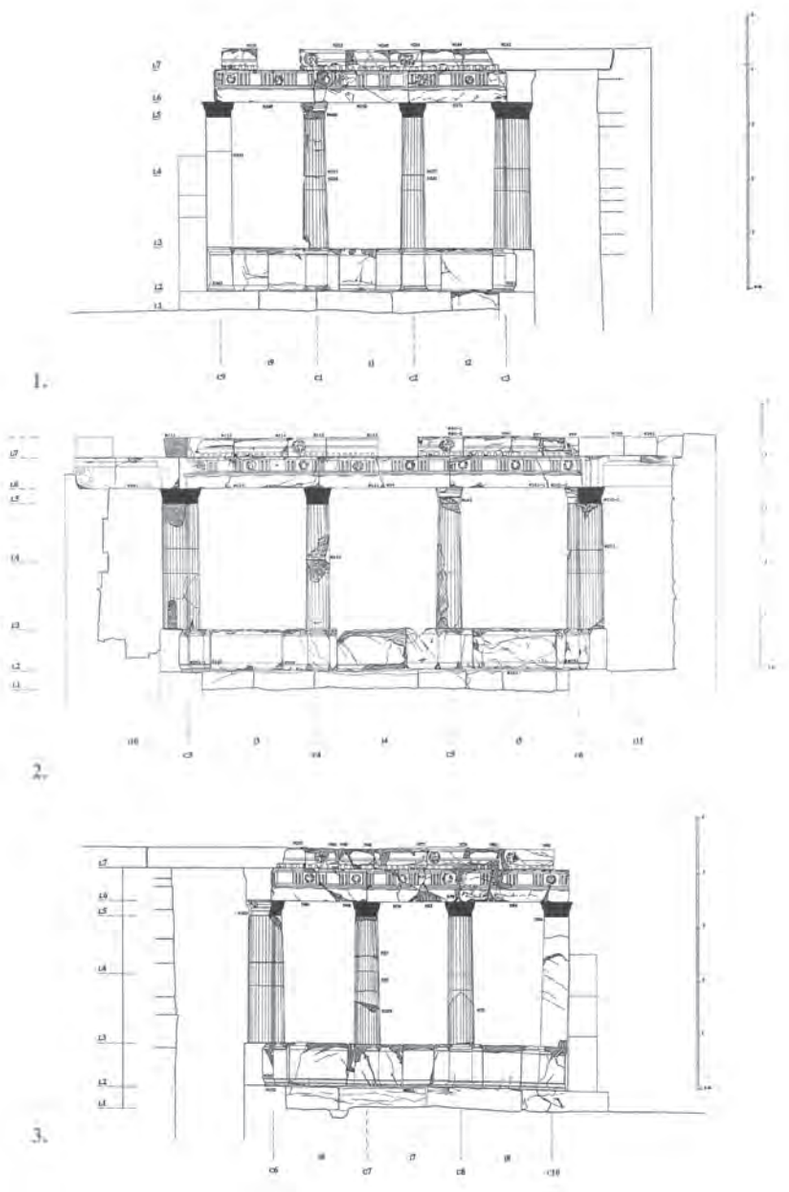

Figure 18 – Second level of anastylosis, introducing the new carved capital.

The Final anastylosis

The architectural research for the existing in-situ remains demonstrated and quantified the movement suffered by the structure during its destruction by the earthquakes. The earthquake forces induced a movement of the structure in the Southwest / Northeast directions. This resulted in the total collapse of the west and east porticoes, in a partial destruction of the west wall and in inducing a strong tilt in the wall to the east side and the consequent slipping of the foundations of the east and west porticoes. Since the beginning of the excavations and its consequent restoration, we wanted to avoid dismantling the still in situ remains of the structure in order to preserve, as far as possible, the structure's original integrity. Therefore, for the reconstitution of the porticoes, it was necessary to dismantle the in-situ elements in order to correct their levels and positions. The heavily damaged load bearing column bases were consolidated. The foundation level was corrected with natural hydraulic lime mortar mixed with small rubble; which provided a correctly levelled bed. After replacing the basin parapets the foundations were strengthened by the injection of a plastic hydraulic mortar to increase the contact area between the stones of the foundations and the stones of the bed rock on which they were placed.

After stabilising the foundations and column bases it was possible to start the final anastylosis of the restored blocks. Originally column drums and capitals were linked by vertical iron dowels set in square blocks of lead. The architraves were posed directly on the capital and interconnected with P-shaped rectangular iron cramps that were also protected with lead. For the reconstitution of the vertical dowels fibreglass dowels of 15 mm diameter and 10 cm length were used, which were fixed in the original dowel holes by means of an epoxy grout (Figure 12). For the cramps a rolling pin made by a fibreglass mesh was prepared, placed into the original cramp holes and fixed also with an epoxy grout. The intention of these dowel and cramp connections is not to create a rigid connection, which will cause the crushing of the blocks in case of a severe earthquake's but to protect the original blocks by breaking just before the stone breakage and realising the blocks to consume the imposed energy through free movement.

The nowadays image of the Nymphaeum

With this paper, we wanted to express the guidelines of our decisions, the reasons for ours choices, and the results of our actions concerning the stone restoration. We wanted to express how it was possible with a ruin and some 300 stones and fragments to revive the history and the structure of the Nymphaeum of Sagalassos.

The system used for the restoration of the stone blocks of the Nymphaeum - the Fiberglas-epoxy system - had as main goal to join and integrate the stone elements so that they will be as strong as their monolithic form, and when connected in the structure - different stone elements connected vertically and horizontally - the connection will be less strong than the stone itself (Ercan [et al.] 1997). Having a high mechanical strength, the system makes it possible to strengthen the members and the structure itself with minimum intervention. Moreover, the system is compatible with the stone because it acts as a unit in itself and as a whole with the stone, creating a perfect bond. The retreatability of the system can be guaranteed with the applied dimensions. The starting point set by the objective of looking for a repair technique based on conservation principals of minimum intervention, compatibility and retreatability has helped to find a new technology much more adapted to the requirements formulated in this anastylosis project.

Nowadays the Late Hellenistic Nymphaeum presents an inestimable value for the society, for the site, for the region, and for the world of archaeological conservation: the recovering of its structural integrity, the suggestion of its original beauty, and the salvage of the original Nymphaeum function as a fountain.

Many questions must be considered with the choice of restoring methods and, this makes the mission of restoring and presenting architectural ruins so difficult and so engaging. The nowadays restitution of the Sagalassos Nymphaeum answers in our point of view, to our premise concerns. From the beginning, we knew that at the same time we had to protect the ruin, to prolong its existence, to preserve its symbolic character and to make it more readable to the visitor. Today, the visitor of Sagalassos will not anymore see a ruin frozen in time with a panel in front. He will see again an architectural object; he will understand it in its totality and will repeat the same journey as 21 centuries ago - walking from the centre of the city to the Theatre, taking a rest at the fountain house to have same fresh and cold water.

Acknowledgements

This paper was possible thanks to the collaboration of the engineer S.Ercan and to the Prof ir.arch. K. Van Baelen and is a revised version of the paper presented at the 6th International Symposium on the Conservation of Monuments in the Mediterranean Basin, April 7-10, 2004 in Lisbon.

This text presents research results of the Belgium Programme of the Interuniversity Poles of Attraction initiated by the Belgium State, Prime Minister's Office, Science Policy Programme. Thanks are due to the Fundação para a Ciência e Tecnologia – Programma PRAXIS XXI, Lisboa, for a grant for the architectural research.

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