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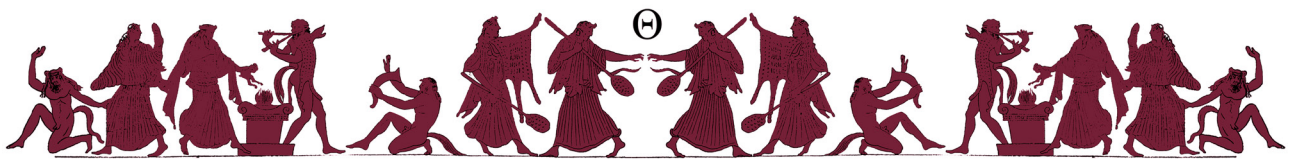
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THE RECENT INTERVENTION PROGRAMS ON THE MONUMENTS OF THE ATHENIAN ACROPOLIS

Vasiliki Eleftheriou*

Keywords: Acropolis, anastelosis, architectural fragment, Athens, clamp, Cultural Heritage, dowel, fastening system, Parthenon, Pentelic marble, Propyleia, restoration of monuments, reversibility, reintegration, titanium.

Parole chiave: Acropoli, anastilosi, Atene, frammento architettonico, grappa, lacuna, marmo pentelico, Partenone, Propilei, restauro dei monumenti, reversibilità, reintegrazione, sistema di fissaggio, tenone, titanio.

Abstract

An extended restoration program of the Athenian Acropolis monuments has been in progress since 1975. The project is carried out by the Hellenic Ministry of Education and Religious Affairs, Culture and Sports in order to alleviate the effects of serious problems due to natural causes (i.e. earthquakes) or human activities (i.e. fires, bombardments or earlier restorations). The interventions are complied with the spirit of the "Charter of Venice" and follow the principle of reversibility. Effort focuses on keeping the original construction form of the monuments. New marble is used for supplements only to ensure the structural stability of the buildings, while iron clamps and dowels are being replaced by reinforcements made of titanium. The authentic reliefs and sculptures are removed and transferred to the Acropolis Museum and replaced by casts in artificial stone. Scattered architectural fragments recognized as belonging to the monuments are reset in their original or a corresponding position. The paper focuses on the recent intervention programs on the projects underway at the Propylaia and the Parthenon.

Un esteso programma di restauro dei monumenti dell'Acropoli ateniese è in corso dal 1975. Il progetto è realizzato dal Ministero ellenico della Pubblica Istruzione e degli Affari Religiosi, Cultura e Sport, al fine di attenuare gli effetti di gravi problemi dovuti a cause naturali (ad esempio terremoti) o antropiche (ad esempio incendi, bombardamenti o restauri precedenti). Gli interventi rispettano lo spirito della "Carta di Venezia" e seguono il principio della reversibilità. Gli sforzi si concentrano su come mantenere la forma costruttiva originale dei monumenti. Il marmo nuovo è utilizzato per quelle integrazioni necessarie a garantire la stabilità strutturale degli edifici, mentre grappe e tenoni in ferro vengono sostituiti da elementi di rinforzo in titanio. I rilievi e le sculture antiche vengono rimossi e trasferiti al Museo dell'Acropoli e sostituite da calchi in pietra artificiale. Frammenti architettonici sparsi riconosciuti come appartenenti ai monumenti vengono ripristinati nella loro originale o una posizione corrispondente. L'articolo illustra i recenti programmi di intervento sui progetti in corso presso i Propilei e il Partenone.

Introduction

In 1975, the Hellenic State established an interdisciplinary Committee, the *Committee for the Conservation of the Acropolis Monuments*. This event marked the beginning of a new period regarding the restoration of monuments in Greece, which was characterised by the implementation of scientific methods and specific guidelines. Under the general supervision of the Committee for the Conservation of the Acropolis Monuments, a special service of the Ministry of Culture, the *Acropolis Restoration Service (YSMA)* was established in 2000.

The great program of restoring the Acropolis monuments begun in 2000 with funding from the 3rd Community Support Framework and was completed in 2010. In the recent years, however, new studies have been carried out for the implementation of new interventions in areas of the monuments where structural problems are evident. The new interventions on the monuments started in December 2010, with funding from the National Strategic Reference Framework (NSRF) (fig. 1).

Monuments are usually damaged by mechanical chemical and biological factors. We can categorize the mechanical damages into the ones resulting from physical disasters and those caused by the human actions, like change of the building's function or effects of previous restorations. The previous restorations are not only responsible for using inappropriate materials, cement and iron as a rule, but also for inaccurate placements of old architectural members coming from the collapsed areas of the monument.

The initial aim *today* is to face the issues related to the structural stability of the buildings. Thus, the areas chosen for restoration are the ones which have suffered the most severe damage and those in which broken marbles and serious displacements have been observed.

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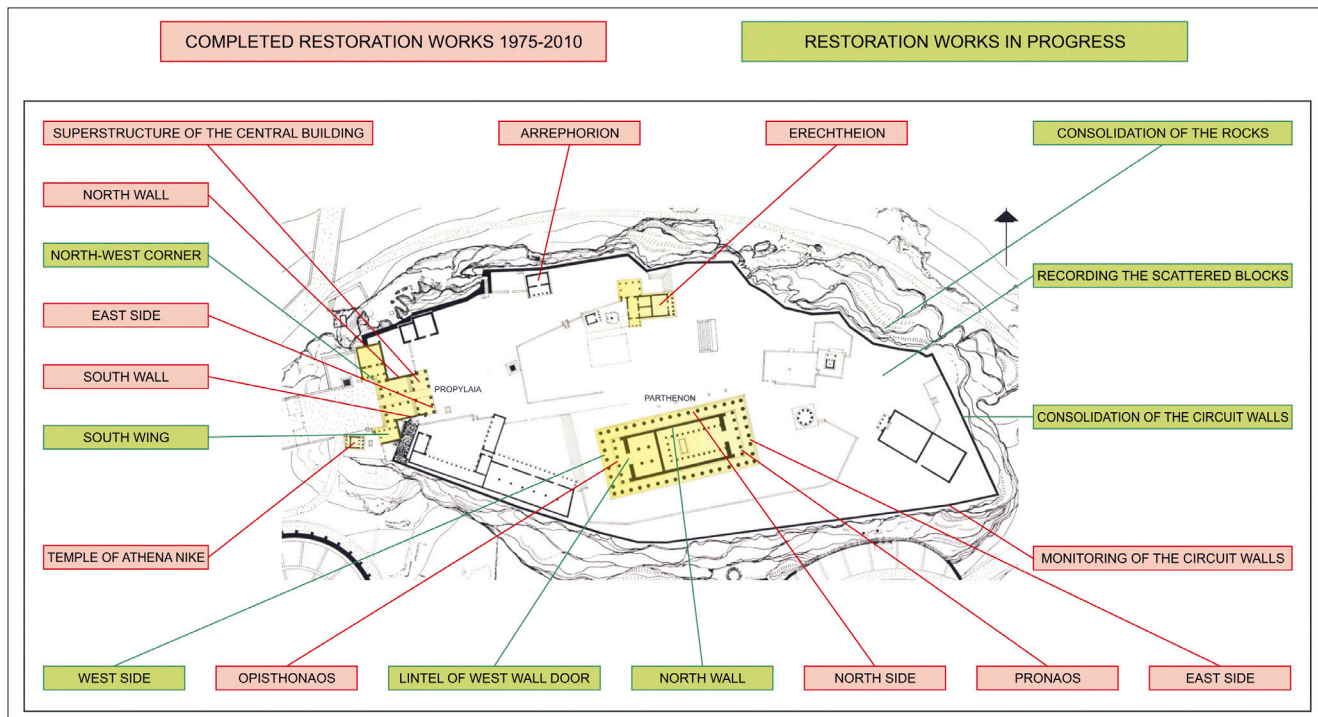


Fig. 1. Plan of the Acropolis showing, in red, the restoration projects that have been completed and, in green, those still in progress (drawing P. Psaltis 2010).

The principles of the interventions

The interventions on ancient and historical monuments are imbued with the spirit of the “Charter of Venice” (1964), Some of the principles are:

- **Restriction of the interventions** to those which are absolutely necessary.
- Respect for the **original material**, the **structural autonomy** of the architectural members and their **original structural function**.
- Compatibility of the new materials with the authentic ones, used for the original construction of the monuments.
- Full **transparency** and systematic documentation during the works and, on completion, full presentation of the works to the scholarly world and the general public.
- Additional principles have been established for the monuments of ancient Greek architecture, such as the principle of **reversibility** of the interventions.

The materials and the methods of the interventions

Interventions are restricted to those parts of the monuments that have been damaged in earlier restorations or present structural deficiencies. In cases of severe damage, the particular part of the monument is dismantled (fig. 2). The process of dismantling includes the removal of rusted reinforcements (fig. 3) and filling material.

After the members are removed, they are structurally restored in the laboratory. New Pentelic marble is used when supplements are necessary. The supplement is joined to the ancient marble with titanium reinforcements and white cement mortar. The diameter and depth of the titanium rods are determined on the basis of structural efficiency. The sockets for the titanium reinforcements never penetrate the outer surface of the members.

The authentic reliefs and statues are carried to the museum and replaced by casts in artificial stone. In addition to dismantled architectural members, scattered ancient members, which have been recognized as belonging to the monuments, are reset to their original position or to a corresponding one. In a few cases, for reasons of stability, it may be preferable to set a few architectural members made entirely of new marble rather than using ancient members preserved in very fragmentary condition.

After their restoration, the architectural members are reset in their original locations and joined by means of titanium clamps and dowels. During this procedure, geometrical distortions in the area being reassembled are removed, so that the original appearance of the building is attained to the extent possible.



Fig. 2. Dismantling the blocks of the west side of the Parthenon (photo V. Eleftheriou, 2012).

The main programs in progress on the monuments of the Propylaia and Parthenon

Propylaia (2011-2015): the following three programs are in progress in the monumental portico of the Acropolis:

1. The restoration of 19 blocks in the south wall of the central building (fig. 4). Two wall blocks and a crown block, in replacement of the one exhibited in the British Museum, were made in new marble. The program of the anastelosis of the south wing has been completed¹.

2. Sixty fragments that come from forty-three blocks of the south wing of the Propylaia will be restored to their original positions. These fragments are among the architectural pieces that lay scattered on the Acropolis rock from the time of the demolition of the Frankish tower in 1875. Additionally, fifteen ancient blocks that were used for the construction of the Frankish tower will be dismantled and placed to their original positions. This restoration program², in which the use of new material is limited (less than 10%), not only will protect the architectural members themselves, but it will also make the south wing of the Propylaia more intelligible to the wider public. The program is in progress (fig. 5-6).

3. The restoration of the northwestern column of the central building. In order to consolidate the column capital and the members of the entablature, eleven blocks will be dismantled, while in total fifteen blocks will be reset to the monument³. Moreover, five column drums will be restored in the colonnade of the west façade of the Propylaia. The program will start in September 2013.



Fig. 3. Removal of rusted iron reinforcements from the blocks of the Parthenon (photo Christodouloupoulou 2012).

¹ According to the study of K. Karanasos and V. Papavasileiou.

² According to the study of T. Tanoulas, M. Ioannidou and V.

Papavasileiou

³ According to the study of K. Karanasos and V. Papavasileiou.



Fig. 4. Propylaea after completion of the restoration of the southeast corner. Two wall blocks and a crown block made in new marble have been completed (photo V. Eleftheriou, 2012).

Fig. 5. Propylaea: dismantling of blocks in south wind (photo V. Eleftheriou, 2012).

Fig. 6. Propylaea: Dismantling of blocks in south wind. View from southeast (photo V. Eleftheriou, 2012).

Parthenon (2011-2015) The works on the Parthenon proceed on three fronts and include:

1. The carving of the flutes of the north side of the Parthenon (fig. 7). After the anastelosis of the north colonnade of the Parthenon⁴, the final surface of the flutes remains to be carved on the surface of the new supplements in the drums of six of the restored columns (fig. 8).

⁴ According to the studies of K. Zambas and L. Lambrinou.



Fig. 7. Parthenon: Carving the final surface of the flutes on the surface of the new supplements (photo Christodouloupoulou 2012).

Fig. 8. The Parthenon after completion of the reconstruction of the north side. View from north. (photo V. Eleftheriou, 2010).

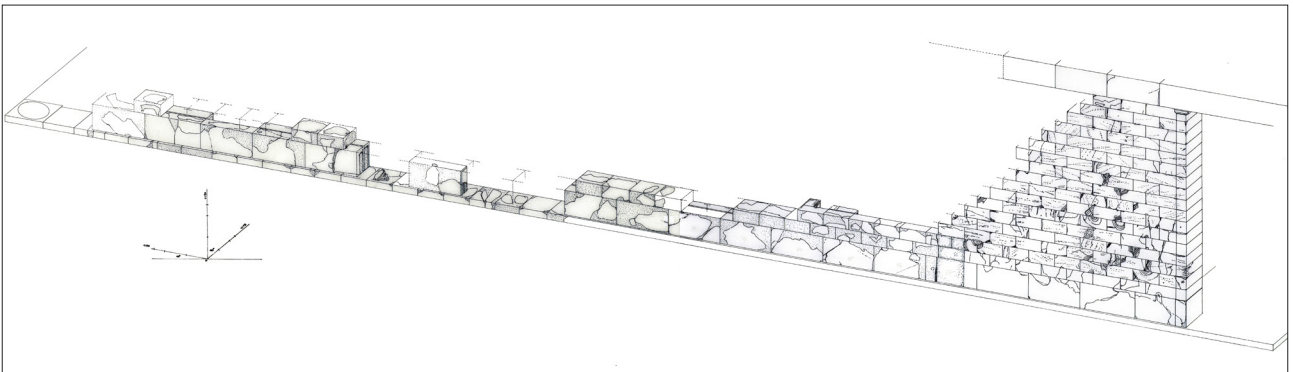
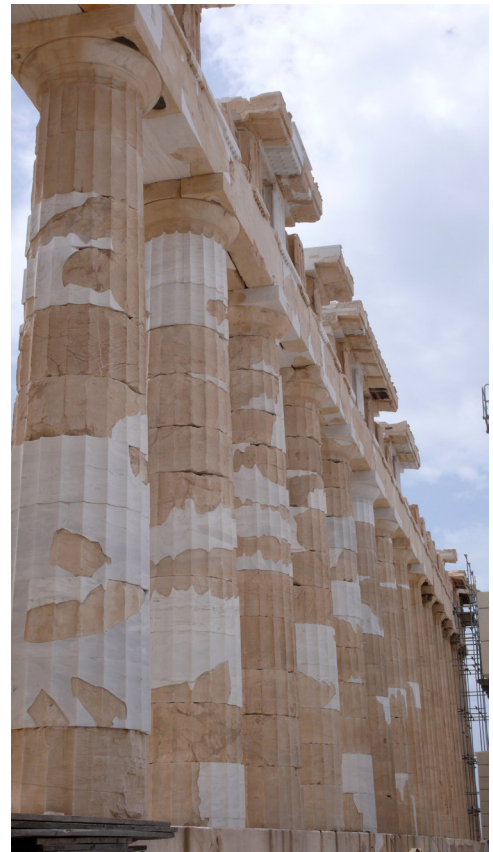


Fig. 9. Parthenon: proposal of the restoration of the lowest part of the north wall (drawing N. Toganidis, T. Skari 1997).

Fig. 10. Parthenon: the underway restoration of the orthostates of the north wall of the cella. (photo V. Eleftheriou, 2010).

2. The restoration of the orthostates of the north wall of the cella (fig. 9). The programme of 2011-2015 calls for the restoration of 15 ancient blocks of the exterior course. They are to be reset in their definitive positions after their structural restoration⁵ (fig. 10).

⁵ According to the study of N. Toganidis.



Fig. 11. Parthenon, the upper part of the west pediment. Mechanical damage. Fractures due to the expansion and oxidation (rusting) of the iron dowels used in earlier restorations. View from north (photo V. Eleftheriou, 2008).

Fig. 12. Parthenon, back side of the west pediment (photo V. Eleftheriou, 2006).



3. The most important work on the Parthenon is the intervention on the west side of the monument.

3.1 The previous restoration

The west side was restored by N. Balanos during the first period of the anastelosis of the Parthenon. The purpose of the new intervention is to cope with the serious structural problems and deformations in that part of the monument, which are due to the destructions of the past, to the previous anastelosis, and also to the earthquakes that have struck the monument. The works, carried out from 1900 to 1902, included dismantling of blocks, limited fillings of new marble and many joints – strengthened with more than 100 iron joining elements. Characteristic is the way in which four fragmentary column capitals were filled in with new marble. The fillings were wedged into the ancient pieces, the broken surfaces of which were trimmed accordingly.

3.2 State of preservation – pathology

In 2007, in the framework of a general planning of the Parthenon interventions, examination of the state of preservation of the west side of the monument was begun. The superstructure of the west side held surprises in store, as inspection revealed the degree to which the surfaces and most of the external metal joining elements had suffered corrosion (figs. 11-13).



Fig. 13. Parthenon. West side. Exterior iron joining elements by the earlier interventions on the Acropolis monuments (photo V. Eleftheriou 2007).



Fig. 14. Parthenon. Northwest corner: Structural problems on the architraves of the north corner. View from west (photo S.Gesafidis 2007).



Fig. 15. Parthenon. Northwest corner: breaks in the architrave blocks, shifts and projections of architectural members, open joints and unfinished beddings are visible (photo V. Eleftheriou, 2007).

Examination of the entire entablature is showing a notable gradation in the preservation of the ancient surfaces. The surfaces of the central area, which appears to have suffered more during the ancient fire, are in a particularly bad condition. The cutting off of projecting parts of the figures of the metopes is overwhelming and has caused acceleration in the erosion of the surfaces.

Even so, it is the areas of the two corners that present the most acute structural problems. Discernible are breaks in the architrave blocks, shifts and projections of architectural members, open joints and unfinished beddings.

Serious problems are seen in the exterior blocks of the two corners, where there are breaks that run right through the block, the penetration being due to the architrave blocks of the long sides which converge on these positions (fig. 14-15). After the earthquakes of 1981 and 1999, a crack of 1 cm appeared in the exterior block of the southern architrave, at the SW corner. These breaks are consistent with the general picture of deformation in the entire colonnade, which indicates that the corners have shifted outwards.

The column capitals have suffered damage of various sorts from the overlying blocks. Breaks in the mass of their especially fine marble, caused by the ancient dowels of the architrave blocks, are observable in all the column capitals.

The addition of exterior iron joining elements by Balanos, along the full length of the entablature and the pediment, has caused extensive cracking and breakage, as it has been also noted during the earlier interventions on the Acropolis monuments.

As it has been observed in earlier studies, the courses of the entablature have suffered significant horizontal displacement in an East-West direction, with characteristic outward shifting of the corners, forming a concave curve in plan. This deformation has been verified with new measurements. At the level of the architrave the deflection was measured 7 cm and at the horizontal cornice blocks 12 cm.

Horizontal shifting of the blocks in a North-South direction is shown by the opening of the thrust joints, evident for the most part in the architrave and the cornice. The total shift along the length of the façade is calculated at some 6 cm.

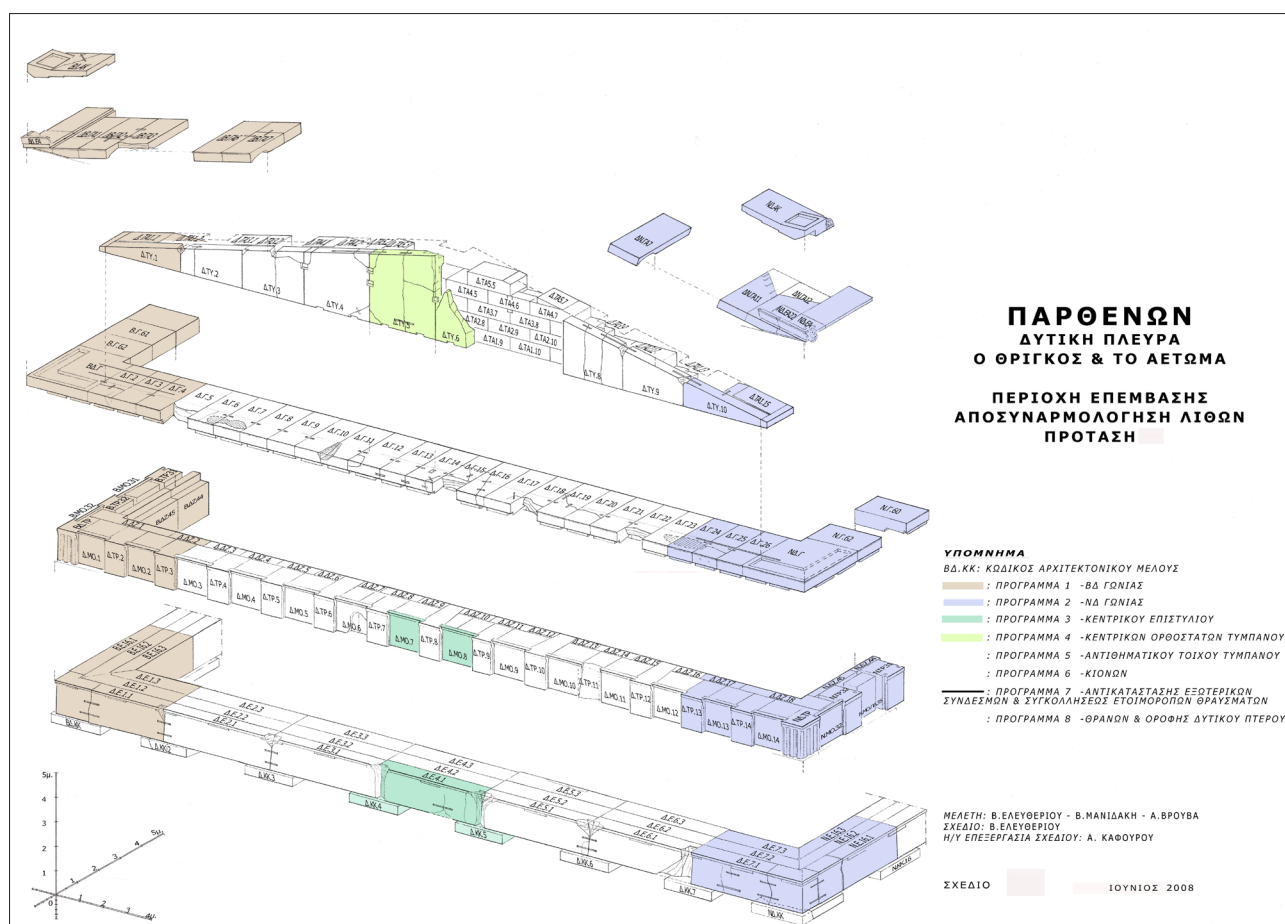


Fig. 16. Parthenon. The restoration sub-programs of the entablature and pediment of the west side. The restoration works at the two corners are indicated in purple and blue color. The future/imminent interventions on the damaged architectural members are indicated in light green and dark green color (drawing V. Eleftheriou, A. Kafourou 2008).

3.3 The sub-programmes of the new interventions

It is proposed to divide all the works in the west side of the Parthenon into 8 sub-programmes (fig. 16). The programmes regarding the two corners of the monument together with the replacement of the exterior joining elements are of immediate priority. The other five programmes are to be carried out in the succeeding phase, after analytical studies are made.

3.4 The sub-programmes 1-2. The work process

The Restoration of the broken architraves of the two corners is technically feasible, with the partial dismantling of the blocks of the west side. To begin with, the dismantling would be carried out in the areas in which N. Balanos intervened in 1902. It would, however, be extended as far as the architrave blocks of the corner intercolumniation, the breaks in which were at that time repaired with large iron reinforcements that were placed on the façade of the monument⁶.

Surface conservation will be carried out on all blocks to be dismantled and on all blocks lying on the ground.

The Potain crane, which had been used in the works on the north side of the Parthenon, was installed in the west side of the monument. The disassembly works initiated in May 2011 and have been completed (figs. 17-18). A total of sixty-two architectural members from the north-western corner and forty-nine from the south-western corner were dismantled. Dismantling reached the level of the column capitals. The greatest difficulty lies in the extremely heavy, up to 8,5 tons, architrave blocks. Of the twelve blocks that were dismantled, five were already broken, while three more had structural problems to a lesser degree. For this reason, special arrangements were required for their support before removal.

⁶ According to the study of V. Eleftheriou, V. Manidaki and A. Vrouva.

Fig. 17. View of the Parthenon before the restoration of the west side. View from west (photo S. Mavromatis 2006).



Fig. 18. Parthenon. Current restoration works at the two corners of the entablature of the west side. View from northwest (photo T. Souvlakis 2012).



Seven metopes, four from the north-western corner and three from the south-western corner were dismantled and transferred to the New Acropolis Museum. These metopes are the last sculptural decoration that is being removed from the Acropolis monuments. Ten ancient metopes will remain on the Parthenon, where they will receive conservation *in situ*. Furthermore, the copies of the two pedimental sculptures of the west side, Kekrops and Kallirrhoe, which had replaced the originals in 1976, were removed. Copies made of a cast material will take the place of the removed metopes and pedimental statues.

Organic materials, such as bones and fruit stones as well as a few metal objects were discovered in the filling material in the spaces between the architectural members, during the dismantling procedure.

Of the one hundred eleven dismantled architectural members, sixty had structural problems. These were due to the action of the metal clamps in combination with the quality of the marble and, in addition, to the movements caused by seismic activity (fig. 19). As soon as the ancient blocks had been lowered, the work of structural restoration began (fig. 20). Twelve blocks have been structurally restored to date. The resetting of the blocks will begin as soon as the structural restoration of the column capitals will complete, and will last 3 years.

This intervention, apart from the restoration of the broken architrave blocks, allows for other important improvements of the structural condition of the corners, such as:

1. Resetting of the architrave blocks in their original position in relation to the adjoining architrave blocks and considerable reduction of the marked deformation of the façade. It is feasible to close the joints of the corners that have opened and to correct by approximately 50% the horizontal deformation of the entablature.



Fig. 19. Parthenon. West pediment: Structural problems due to the action of the metal clamps in combination with the quality of the marble and, in addition, to the movements caused by seismic activity (photo T. Souvlakis 2012).

Fig. 20. Parthenon. West side: Since the ancient blocks had been lowered, the work of structural restoration began. (photo V. Eleftheriou 2012).



2. Improvement of the stability of the corner columns, since relieving them of their load allows the return to their original state of equilibrium, improving the resting surfaces of the drums between each other.

3. Improvement of the bedding of the architrave blocks and overlying members, thus decreasing the opening of the horizontal joints, such as, for example, the currently visible opening between the triglyphs and architrave blocks.

4. Replacement of the particularly damaging dowels of the architrave blocks that have penetrated the column capitals.

The purpose is not to repair all the damage, since this would entail interventions on a grand scale reducing the authenticity of the monument. The goal is to preserve the building with the least possible intervention, such as the restoration of broken members and joining elements, and especially the restoration of the basic members of the load system, namely the architrave and the column capitals.

Epilogue

Despite the financial difficulties that our country spends, we believe that we will manage to complete the project on time. Additionally, the experienced staff working on the monuments restoration increased with new staff that was recruited, chosen on the basis of strict criteria in terms of scholarly training and specialization in the work of restoration. So, 3 years is enough time to reset the structural restored marbles to their original position and to deliver the restored monuments to the international community.

The Acropolis Restoration Service after 35 years of work is at the forefront of the restoration of ancient monuments thanks to its high craftsmanship, its employed methodologies, its close connection with research and technological developments.

In addition to the restoration works on the Athenian Acropolis, YSMA is dealing with activities such as documentation using modern technology, the development of the database and educational programs. The work of the Acropolis Restoration Service YSMA has been presented in many conferences and has achieved international recognition. All activities are also presented to the public through different channels, such as the service's webpage (www.ysma.gr) and a series of public information programs, especially for children⁷. Young people are given the opportunity to participate to different educational activities inside the museum or on site that enhance their knowledge in relation to the history of the monuments and the restoration practices.

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⁷ <http://www.parthenonfrieze.gr/> <http://acropolis-virtualtour.gr/> <http://www.acropolis-athena.gr/>.