

DOCUMENTATION OF DESTROYED PARTS OF MONUMENTS USING LOW COST RECTIFICATION TECHNIQUES

Georgios P. Antoniou

Architect Engineer, Ioannou Soutsou 44-46, Athens, GR - 114 74, antonioug@tee.gr,

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ABSTRACT:

For many monuments under restoration or anastylosis there is not proper documentation and recording. That becomes more essential for the intervention when there are missing or collapsed parts of the monument. Therefore it is absolutely necessary to obtain any information available and apply them to the project. Such kind of information is old photos and other reliable illustrations of a monument which present missing or destroyed parts. The reliable data which can be obtained out of them are not only the type of materials but mainly the dimensions of the missing areas of the construction. Even though there is professional photogrammetrical software which exploits old and unreferenced photographs, the application of low cost techniques is more suitable for small monuments or for cases where is not easy to employ specialized engineers. In such cases the implementation of simple image processing software along with a typical CAD application can provide quite accurate data and a rectified or an ortho-photo. The most common situation of that kind is when a whole part of it is missing and is illustrated on an old photograph. Another is the case when a number of distinctive fragments of the monument are visible on a photograph. Finally there is the case of a lost monument shown on a picture with a construction which still exists. In all cases a rectification is possible after the insertion of measurements from the surviving parts which are being illustrated in the pictures.

1. INTRODUCTION

1.1 Problems and Demands

The lack of proper documentation and recording of monuments under restoration or anastylosis, results in difficulties and problems on the studies for these projects and the integrity of the final intervention as well. The reasons for the absence of proper documentation and recording are multiple and vary according to the monument and its position.

That fact influences the equivalent restoration projects mostly on the data given about the original or the previous status of the construction, which finally has to be restored. Usually the problem is related to collapsed or destroyed parts of the monument, which has to be restored, and there is not any reliable documentation for its original form and geometry. Moreover, it is usually difficult to recognize and justify the parts of the construction and their authentic position on the monument.

1.2 Capabilities of the Low Cost Photogrammetry

In such situations all the existing documents have to be used, combined with contemporary recording and measurements, conventional or digital ones. The types of these existing documents are mostly impromptu or detailed photographs and/or some scaled or detailed sketches. The photographs are not rectified and none of them embodies any photogrammetric data which could result the processing and rectification with the typical photogrammetric tools and techniques. In addition to that, in most cases it is not easy to apply such methods or include them in the project because of financial or bureaucratic reasons. The implementation of some Low-cost photogrammetric techniques on the existing documents can result in well applied data for the restoration. Furthermore, it could be practiced by engineers without much relevant specialization.

There are already cases where a proportional/similar/equivalent technique of that kind has been applied successfully, providing reliable recording even for monuments lost in total, like the small hermitage cell of the monk on the top of the columns of Olympieion in Athens, documented by prof. Ch. Bouras after photographs dated at the end of 19th cent. (Bouras, 1996) A case of a half collapsed monument, at the monastery of St. Demetrios at Stomion (Tsagezi), which was originally recorded with the *Camera scura* technique, was calculated totally also by Prof. Ch. Bouras. (Μπούρας, 2003)

2. METHODOLOGY

The methods described below can be easily adjusted to the specific requirements of various cases of monuments, according to their size, the position and the expense of the missing part and the reference points and measurements which can be obtained.

2.1 The general concept

The major aim is to provide the essential measured data which can make possible the rectification, or the orthorectification, of the existing images. The analysis of these images and their comparison mainly with the nearby surviving parts of the monument, determines the type, the amount and the precision of the recording and measurements which are needed for that. These data can be either acquired by conventional or digital methods, depended on the site, the monument, and its condition of preservation.

2.2 Acquiring reference points and measurements

The measurements, or digital data, taken should expand and cover at least two sides of the missing part of the monument

which is presented on the existing image. The procedure should be focused on well and easily recognized spots of the surviving part, which can be easily identified on the existing image. Consequently the rectification of that image will be much easier and the results more precise. In difficult cases and recording of wider areas, a network is needed in order to achieve a rectified product with reliable and usable precision.

2.3 Process of Rectification

The rectification can be easily achieved by combination of simple functions of image processing software (like Adobe Photoshop etc.) These functions are transformations with distortion, scaling, change of the perspective etc.

Secondary small scale adjustments can be achieved also by CAD software (like Autodesk Autocad etc). There scaling of blocked images with different ratio in per axis can refine minor dispositions.

2.4 Drawing and Dimensioning

Finally a linear drawing is produced after the rectified images are inserted in CAD application. The drawing should be double checked according to the adjustment of the rectified photograph on the drawn existing part of the monument.

3. VARIOUS POSSIBILITIES

3.1 Missing parts of a monument

One or more parts of the monument are missing but they are visible in one or more photographs or images produced before the distraction of these parts.

Usually there is no any photogrammetrical data of the pictures. Rarely the type of the camera is known and therefore the focal length is given if the camera had a fixed lens. But also in these cases there are neither reference points nor the distance between the camera and the building is known.

In the majority of the cases is essential to acquire the right measurements and determine as many reference points as possible on the surviving part of the monument which are visible on the photographs under rectification. The selection of these points has to fulfil the specifications listed below:

- To be well distinguished on the existing photographs.
- To delimit one or more triangles.
- Not to be too close to the edges of the photograph (too much distortion from the lens)

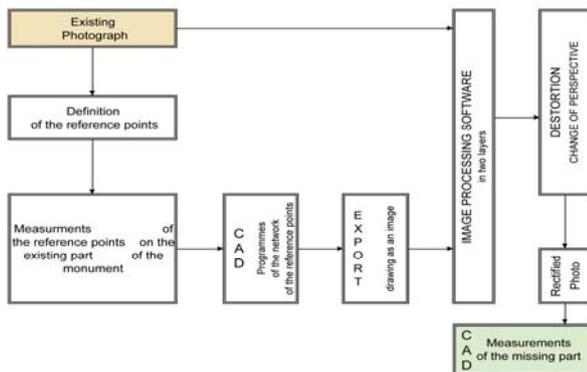


Figure 1. Flow chart of the major methodology

These points which are the guides for the rectification are drawn in a CAD application and afterwards are exported as an image file, preferably Jpeg or Tiff. That image is inserted along with the photograph under rectification in image processing software. There, the original image is distorted, scaled etc so the equivalent points coincide with the drawn ones. The more the reference points are, the greater the accuracy will be.

3.2 Visible distinctive fragments miss positioned later on

This is the case where a number of distinctive fragments of the monument are visible in one or more images and they are well recognizable as well. These fragments have been dispositioned afterwards because of human intervention or natural causes.

After a rectification of an old photograph, using unchanged up to day points for references; it is possible to achieve the following:

- Identify the mispositioned fragments.
- Testify their original position.
- Reconstruct the authentic form, partially or totally.

3.3 A missing construction shown along with an existing one

This is a different case, because the missing construction has to be projected on the surviving one. For that purpose is usually needed a ground plan including both constructions.

After the projection on the historic photograph is completed and marked, the rectification according to the method of § 3.1 results in the original outlines of the missing construction. (§ 4.3)

3.4 Data extracted out of a detailed engraving

For some monuments there are historic engravings, dated usually in the 19th century, which illustrates the construction in a realistic and detailed way. Therefore they could be considered as a photograph. The basic specification for that -besides the ones mentioned in 3.1- is the natural representation of the features of the specific construction and the presence of well distinguished points which still exist on the monument.

It is the case which according to methodology matches most to the one with the missing parts of a monument. That is because most engravings represent one monument and not fragments, which usually were illustrated not as carefully as a whole building. The same happens in most cases of a construction shown at the background of the main building of the picture.

Then the engraving is being handled as an ordinary photograph.

4. CASE STUDIES

4.1 Hellenistic fortress on the island of Ro

It is situated on the island of Ro, near Kastelorizo in Dodecanese. The most deteriorated part of its construction was the north wall facing the coast of Asia Minor across the sea. There except from the severe inclination outwards had also collapsed the northeast corner, after human intervention on the top. The stone blocks of the masonry there could not be identified easily because it was a medieval modification. So despite the existence of a good photograph taken before the

destruction, more data was needed to identify and testify the stones. Furthermore they had fallen down to the steep slope which faced the sea and that made the identification more difficult.

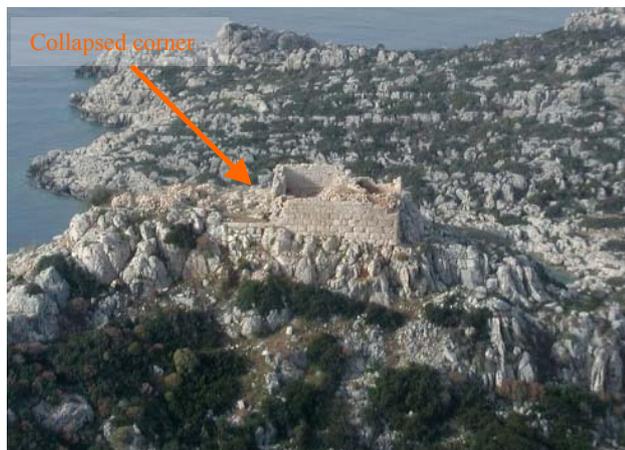


Figure 2. Aerial view of the ancient fortress. © G. P. Antoniou

Many measurements on site provided an accurate network of the regulated masonry joints from the existing part not only on the north wall but also on the eastern one. That network was used for the rectification of the photograph. The picture was inserted in a CAD application. The precision of $\pm 5\text{cm}$ acquired was adequate to determine the dimensions of the missing stone blocks after the drawn elevation of the whole north face of the fortress.



Figure 3. Photograph of the east facade before the collapse of the northeast corner (KB' EPKA)



Figure 4. The north facade before the collapse. (KB' EPKA)

According to these listed dimensions, 80% of the collapsed stones were found on the slope and their original position was identified. (Fig. 5) The project was approved by the C. A. C. and has already been partially applied.

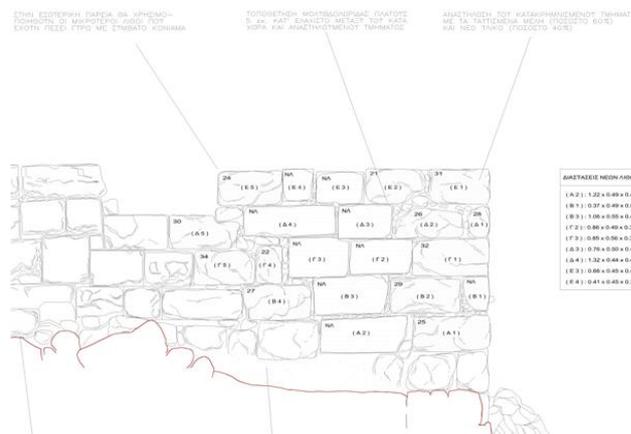


Figure 5. East elevation with the identified stoneblocks (shade)

4.2 Theater of Dodona, Epirus

A part of the study for the Restoration of the Ancient Theater required the identification of the numerous seats and parts of the cave which were misspositioned during the intervention made in 1960, without any previous documentation. Such identification of the original position of many parts was possible using some simple general view photos, taken before that intervention and the detailed documentation of the cave made by the photogrammetry experts of our team. Because of the curved layout of the cave, the method was applied with multiple partial rectifications of the most suitable photograph. (Fig. 6)



Figure 6. View of seat tier 1, Zone A before the intervention of 1960

The detailed measurements supported the data from the photogrammetric products. Some of these results have already been embodied at the Study for the Restoration of the Ancient Theatre of Dodona. (Αντωνίου, 2005) In this case it is possible to identify in which position are today most of the edolia of the seat tiers K1A and K2A, visible in that image taken before the intervention of 1960.



Figure 7. Edolia with their position before 1960 testified (blue)

4.3 The elongated monumental base by a retaining wall

The base, which does not exist any more, is shown in an historic photograph of the 2nd half of 19th century, illustrating just the west part of it. The base is consisted of 2 steps plus the foundation stone which was originally protruding out of the ground. (Fig. 8)

In the historic photograph all the pieces are illustrated clearly. At the background of the base, it is visible part of the retaining wall of the east parodos of Dionysus theatre in Athens. All that part of the wall survives today and could be recorded in details.

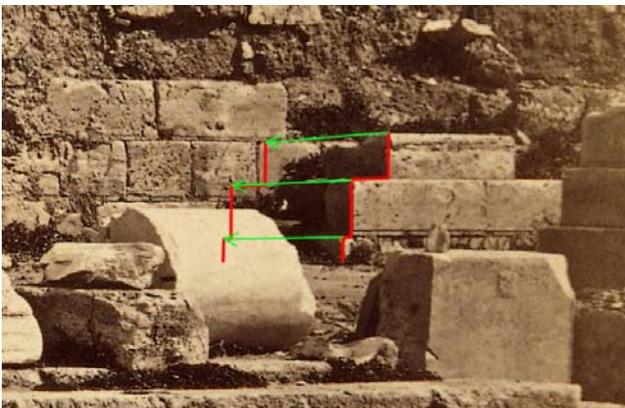


Figure 8. The historic photo with the projection of the base on the wall

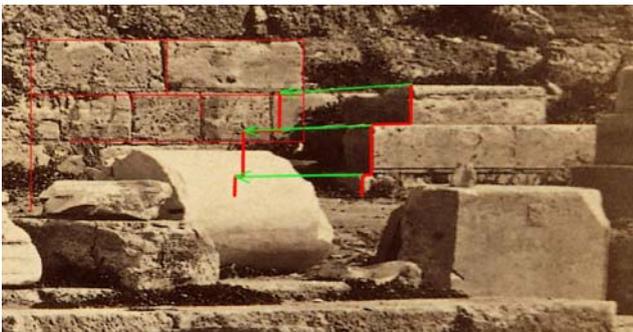


Figure 9. The rectified photo with the projection of the outline of the base.

According to the methodology of that case the outline of the base was projected and marked on the wall. Afterwards the photograph with the marked outline was rectified using as reference the measured grid of the masonry of the retaining wall (Fig. 9). At the end, in the same CAD application, the elevation of the monumental base was drawn in its original dimensions (Fig.10)

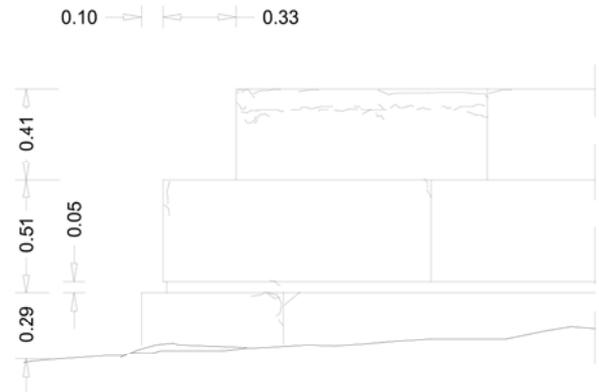


Figure 10. Front elevation of the base in its original dimensions

That case study occurred after collaboration with a colleague for a related archaeological project.

4.4 Experimental examination of the engraving of an Ancient Tower

The engraving of Ludvich Ross, published in 1843, shows the tower of Ag. Triada on Amorgos, from the southeast -outside the yard. Among other parts which survived then much higher than today, is the northeast corner of the central tower. That corner collapsed later on and the stoneblocks fell in the yard where they were recorded in details by the author in 2003, (Fig. 12) after a commission by KB Ephorate of Classical Antiquities for the study of the removal of the stones and other small scale interventions in the yard.



Figure 11. The engraving of L. Ross, 1843 (Ross, 1843)

The engraving was classified as a very detailed one and many of the illustrated parts in it were indisputable identified on the monument today. Therefore it was practiced experimentally the process for the identification of the original position of the stoneblocks of the collapsed corner. The rectification of the engraving using the methodology of case 3.1, resulted in the ability for dimensioning of these stones, as they appear up in their original position. Using those dimensions many of the

fallen stones were identified in the picture, at their original position.

The possibility for an anastylosis is minimal because of the amount of the new material needed to establish the necessary structural strength.

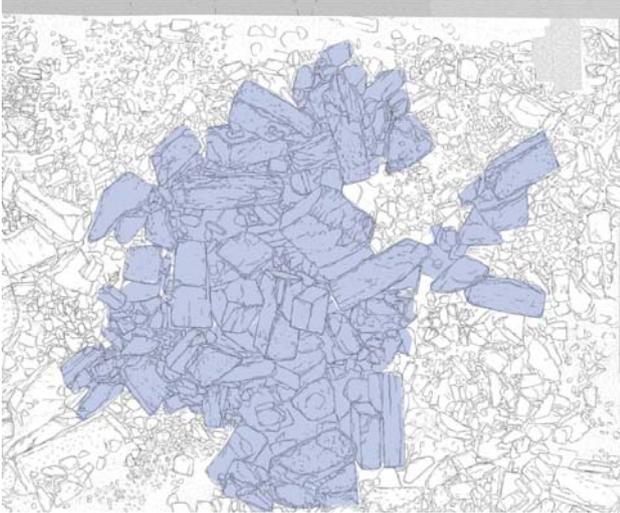


Figure 12. The stoneblocks of the NE corner of the tower after their collapse.

5. CONCLUSION

The best implementation of such low cost rectification methods for recording and documentation requires, on the same time, relevant architectural recording and remarks. Eventually in most cases it provides the essential data for a proper intervention on the part of the monument.

There are numerous monuments where methods like this one could be easily applied, i.e. the south east tower of Aigosthena whose upper part has been collapsed during the earthquake of Alkionides isles in 1981 and there are enough photographs presenting the previous status.

On the other hand the capabilities of professional photogrammetric software have been improved by the time on the field of the old photographs without picture data. But for small simple projects, the advantages of low cost methods will be always tempting.

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