1. Introduction (CV)

In 2003, we kicked off “Project Durrës”, conducted by University of Parma and UNOPS-PASARP, as Pilot Project to “Design and realization of Urban Archaeological Park of Durrës (Albania).”

Starting from this first project, there was a need to integrate knowledge not only on the archaeological feature of the main monument of the city, Roman amphitheater, but also on its architectural feature, as well as its architectural and functional recovery, and on the enhancement in a process of wider urban redevelopment.

In the first intervention proposal for new functions and safety of Roman amphitheater of Durres, was carried out, by archaeologists and experts from the University of Parma, a first stage of analysis of the site and its urban context, in order to acquire the necessary documentation to preservation and enhancement of the monument through a functional reuse.

As a result of this agreement, in 2005, was co-financed by MIUR an International cooperation project, coordinated by prof. Paolo Giandebiaggi related to “Survey of the amphitheater of Durres: knowledge of a monument to develop world cultural heritage”, in which the work started in 2004 has continued through collaboration between different Italians and Albanians partners.

In these missions, we proceeded to carry out different types of survey: archaeological, architectural, and urban, with several integrated methods of survey, as a first step of fundamental knowledge for diagnosis and preparation of projects for restoration and re-functioning of amphitheater.

From these analyzes, we also identified considerations on the functioning and use of space hierarchies that were essential also to direct the planning of archaeological excavations. In the last missions we have finally surveyed, by means of integrated methodologies, findings from excavations carried out by archaeologists, and we have surveyed, in more detail, architectural elements of the amphitheater: arches, outpatient, vomitoria, stairs.

The study conducted on the amphitheater and its context has allowed us to make many scientific collaborations and partnerships between institutions and students of archeology, architecture and engineering form University of Parma and Polytechnic University of Tirana.

The strength of this type of analysis, is definitely in the multidisciplinary approach that has allowed the cooperation of very different skills: archaeologists from Faculty of Letters of University of Parma relating to excavations; architects form Faculty of Architecture and Engineering of University of Parma relating to survey of elevations and different indoor environments, to understanding original functioning of this complex “machine”, up to propose adequate solutions of refunctionalization; geologists from Department of Earth
Sciences, University of Rome La Sapienza for geological surveys; engineers from Faculty of Engineering of University of Parma, to evaluate and resolve problems of stability; planners from DART of Faculty of Architecture of University of Chieti-Pescara, who worked on the new Masterplan for the city of Durres including Recovery Plan on the sector of amphitheater.

There are also many skills specific to different areas of archeology: scholars of Byzantine mosaics from University of Modena and Reggio Emilia; specialists in the study of frescoes and in chemical analysis of the materials and their conservation status from Faculty of Science of University of Parma and many others.

To obtain satisfactory results in complex contexts such as that expressed by the amphitheater of Durres and its urban context, it was crucial to act in a synergistic way, combining different skills, different approaches to the same problem or different aspects of the same, in a way that sometimes is deeply conflicting but only through a constructive synthesis can lead to more complete results, adequate with the ideas that the monument suggests.

2. The first survey (PG)

The first survey conducted by Department of Civil and Environment Engineering, and Architecture of University of Parma, was made in 2004. The goal was making available a basic documentation required for conservation of a monument of such importance, verifying the possibility of enhancement of visible part through an appropriate functional reuse. The lack of precise information about the stability of building and neighboring buildings in relation to a use different than exclusively as museum, as well as the poor reliability and fragmentation of existing graphic documentation, required urgent drafting of a topographic survey of physical limits of building and of its surroundings as well as geometry of excavated parts on which to work out a first proposal about safety measures.

The inclusion of this monument in the context of historical city is characterized by overlap and continuity between the remains of old building and built fabric of the Ottoman city, located within a fortified enclosure, recognizable and, in part, still existing.

This peculiarity has highlighted the need to extend the topographic survey of remains of ancient artifact up to urban around, with a survey aimed at deepening qualitative and quantitative knowledge regard to the area interested by the presence of amphitheater.

Particular attention was in fact aimed to the inclusion of the structure of the amphitheater in the immediately surrounding urban fabric, which has highlighted some geometrical irregularities in the existing maps with significant displacements of some street fronts from the actual position.

Survey was conducted through monitoring architectural object within the boundaries of the most ancient core of Ottoman city, by topographical surveying of amphitheater and its context.

Acquisition of planimetric data was aimed at identifying the “skeleton” describing the profile of amphitheater and planimetric traces of its generating elements.
As a whole, the work has to constitute an important step to studying amphitheater’s architecture and to understanding formation and transformation of urban fabric that surrounds it. It also could provide some useful suggestions for preparation of a draft of new functions, to planning new excavations, respecting initial expectations. Operating modes of this survey were the classic ones of indirect survey based on use of a “total station”. Starting from a closed polygonal, external to the amphitheater, consisting of 9 vertices, we identified more stations within the arena, with addition of further points defined according to the concept of “free station”, bound to the compensation made during calculation of the main polygon, and connected to it. These points, which could be defined as vertexes of an open polygonal of secondary order, were deemed necessary in order to enter by narrow openings, even in tunnels, fornix and ambulacri already excavated in the 60s, to provide a future connection to direct surveys of detail. Vertexes of the polygon of external and internal ramifications, were materialized and positioned so as not to cause damage to the amphitheater’s structures or other valuable elements. Overall, it was taken the position of over topographic 10.031 points. About the amphitheater, it was defined geometry and exact location of remains of the ancient structure and surrounding buildings, some of which falls within the area already occupied by the arena and its steps; work therefore focused on part already excavated and walls of the apparent remains of archaeological monument, as well as the location of fences and buildings are located in area immediate around current archaeological existing ones, along perimeter of excavated parts and those that arise over part not yet excavated, which is about half of the arena and to a third of the cavea (south-east). Instead, the first direct survey covered: shapes of steps already brought to

Fig.1 - Aerial view of the amphitheater and urban Ottoman fabric; Fig.2 - Planimetric representation on photogrammetric basic of topographic polygonal
light; visible portion of the wall of podium, which surrounds the most excavated arena; internal and practicable galleries; trend of radial dividing walls of the north-east area, where we could recognize the access to underground tunnels of private citizens or not accessible. Particular attention has been paid to the survey of north gallery, which identifies the major axis of oval, and to determination and verification of minor axis, which seems to coincide with the chapel obtained in the western part.

It’s important to note how, in similar manner to other known cases, on the ruins of amphitheater, with time, have arisen many buildings that have covered tracks, despite urban fabric show obvious relationships with presence of an artifact, tracking curved and radial axes.

The amphitheater was only partially excavated, after demolition of several buildings, a few decades ago. Other buildings, still existing, have used as cellars any not accessible galleries.

It is also evident from plans drawn up that many of these houses used walls of ancient amphitheatre as foundations or as complex of walls of the lower floors on which the inhabitants have continued with the construction of upper floors.

During 2005, two new surveys have been conducted aimed at integrating and completion of analysis produced in 2004, on an architectural scale.

The first of these two missions, conducted in July had as its main objective the direct survey of all internal galleries and then ambulacri currently viable and accessible. This survey has worked mainly in the south-east area, where we can found the entrance to monument, and in the north-west zone. In the first one, you will find most of the rooms and visit ambulacri, subject of various restoration and recovery interventions since last 40 years. In the second zone the presence of covered rooms is substantial, but operational conditions have, in many cases, prevented a complete survey as these are still partially occupied by soil and debris of various kinds.

These areas, due to the complexity of current situation and walls’ state of conservation, requiring particular attention and therefore a survey conducted mainly in a direct way, postponing the use of electronic devices only to connected the measure with some known points belonging to previous survey.

Even in this mission we have used a “total station” in order to integrate, with the taking of points geo-referenced, survey of some areas particularly interesting following graphical representation made after the first architectural survey.

Total station was also used to conduct, in an experimental test, automatic pick-up points in a grid-set with a pitch equal to 40 cm along the east side of cavea. This allowed to obtain a first external outline of the steps of amphitheater, highlighting the progressive increase in slope rising from ima cavea to summa cavea.

In December of 2005 another survey was organized. In this case, the objective was to obtain a section of the elevation of amphitheater for each of accessible vomitori in the south-east area.

These sections, with radial trend, were produced by integrating the direct measurements, taken primarily in vaulted spaces, with points taken through total station, adapted to describe the irregular shape of external part of the cavea,
consisting, now, only by opus cementicium and therefore no longer from steps. The radial sections designed, as a result of this survey, were 12 and they documented in a comprehensive way the whole area of entry, often used for public tours and exhibitions.

At the end of these measurement the framework of remains of the amphitheater could be said to be essentially complete. However, many points were still some doubts and unanswered questions. The functional organization could not be said as resolved, being the surveyed portions located in areas of connection between built in elevation part and the area of amphitheater nestled in the hillside. This makes these structures abnormal than the other parts presumably regular, compared to ground’s morphological irregularities.

3. Laser scanner survey (CV)

Remarkable geometric irregularity of all surfaces of the ancient amphitheater, due to thousands of years of weather’s action, landslides and depredations, have made it imaginable only through abstract idealization the state of original walls and then the shape as well as presented itselfs at the time of its implementation.

For this reason, archaeological structures survey, carried out with instruments that impose a discretization of points to be taken, it becomes much more difficult at the expense of overall accuracy when we make final graphical representation.

Reconstruction of their shapes implemented through a direct survey, though supported by topographical points, does not allow a sufficient precision to discern the slight differences between an oval shape rather than an ellipsoidal shape, as well as the slight geometrical irregularities of reconstructed parts after subsequent reuse.

Chances offered by advanced survey instruments as a laser scanner, in the-
se cases, they bring considerable advantages firstly giving the opportunity to acquire in a short time millions of points in an undifferentiated way up to cover all surfaces. These points can then be analyzed, reduced and, anyway, organized in search of corners and edges that really describe geometric surfaces, only when we make graphical representation, the only phase where we can keep an overall view of work and we can be supported by alignments wider. These are the reasons that led in 2012 to proceed with a further survey of Durres amphitheater. Since we already have a very detailed topographic survey that connected the entire area and the adjacent buildings through a closed polygon, described above, it was decided to concentrate scanning stations around the area of new excavations, at the center of arena and in internal vaulted spaces. Again, these stations were concatenated together to form always closed triangles and, in some cases, modeled stations still present from surveys conducted in 2004, 2005, 2006.

The end result, given by the union of 22 point clouds from the scans, has allowed us to have an overall three-dimensional view of the whole monument and its immediate around with very low margins of error, all under one centimeter. In this overall final cloud all the structures of amphitheater can be read: part of the wall that borders the arena; the podium; a large part of the cavea, without coating and steps probably marble, and now presented as a continuous surface in “opus caementicium”; some radial walls that surrounded fornix and all the annular galleries, the ambulacri, excavated and released from the soil in the last century. Element still more useful for reading the geometry of monument, point cloud laser scanner allows you to read all of these elements at the same time, in a sort of x-ray that makes semi-transparent every surface structures leaving a glimpse of the parts below.

In the area of archaeological excavations, never detected before, are evident two walls surrounding the central gallery, aligned and opposed the large north gallery still vaulted, though partly rebuilt; and to the right, parts of ancient stairs and the first four fornix.

To the south of Byzantine crape, of uncertain date from the sixth to the tenth Sec, on the walls of the fornix perpendicular to central axis, are recognizable ten walls delimiting as many fornix.

This area, between the transverse west axis and the central south axis, seems to be part of the monument more altered and reused to military, sacral and finally living use, up to the thirteenth Sec³, then subject to excavations and reconstructions since May 19664.

Apart from many anomalies due to these transformations, we can read very well the succession of fornix which, however, appear to be wider than those surveyed near longitudinal axis.

A further set of radial walls are present in the north/east area. Even these showed different widths than those of other areas.

In an attempt to reconstruct the overall geometry of Durres amphitheater, these differences in width of fornix initially putted many doubts to solve which we had to make a comparison with other studied amphitheatres to try to understand what were the constants and variables such as so characteristic of this type of architecture, but also so varied both in size and geographic location.
The comparison with bibliographic amphitheatres of similar size, which the book *L’Amphitheatre romain* by J. C. Golvin⁴ has been our preferred source, was the main tool of analysis: by reading this, we can see that the width of fornix is always constant on the facade, in some cases, with the exception of those on the main axis, representing two large input and output doors. The need to have a constant measure on the front of the monument is surely due to the desire to create a repetition of module facade, divided into overlapping orders of round arches.

The width of cavea, in amphitheatres of larger size, is constant.

From the conducted survey it was possible to identify and track a longitudinal axis starting from the axis of great north gallery and extending it up to the middle of the two walls delimiting south gallery, discovered by recent excavations. The correspondence and alignment are perfect results. Tracing a perpendicular line from the center line of this axis, we arrive exactly on the centerline of Byzantine chapel.

The axes of walls delimiting the south fornex, near new archaeological excavations, all point to a small area located on the longitudinal axis of amphitheater. With small approximations could be deduced a crossing point on the same axis.

The axes of fornex do not all point in the same center but on four different

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Fig. 5 - Laser scanner point cloud: view of cavea and north galley; Fig. 6 - Cross section of the fornix 55 with stratigraphic analysis of masonry

Fig. 7 - Laser scanner point cloud: cross section of fornix 55
centers: the centers of the oval that generates perimeter both of arena that
the whole complex.
Through this last survey there were, then, identified a great number of points
representing the maximum extension of emerged monument: a point in the
north, out of the current fence of amphitheater, where recent work of modern-
ization of the Bashkia square revealed a small portion of wall clearly dating
back to Roman times. Another point is represented by the maximum exten-
sion of vault of the central gallery north. A third wall in the large wall tangent
to Byzantine walls on the east side, near the entrance to archaeological site.
The last point is in the outermost structure emerged from recent excavations.
All these points, while not only describing a curve or a profile, are perfectly
aligned on an oval parallel to the arena’s one. Prolonging the axes of found
fornex until you get to this oval, there has been found the regularity of facade
module, and at this point we could divide this oval in 72 equal portions whose
width corresponds to that of the fornix.
To continue to retrace the tracing process used by the Romans gromatici5 to
set the ground at the base of monument, another problem has emerged as
significant. In the specific case of this amphitheater, ground on which it stood
is not flat. About half of the cavea reclines at the side of a hill, overlooking the
sea and the plain on which city stands. Roman architects have taken advanta-
ge of this situation to reduce the part made entirely in elevation using natural
slope of land to realize the cavea’s steps. If this positioning led undoubted
benefits from the constructive point of view and, we can imagine, from the
economic point of view, has certainly complicated the initial project, breaking
up the complete regularity and symmetry of composition and forcing to find
specific solutions to solve connection points between ground and architecture.
Keeping a perfect regularity in scan composition of façade and plan, despite
problems related to specific ground conformation, process of initial tracking
on the ground must have greatly complicated and conditioned choice of used
methodology.
In the specific case of Durres, definitely there is a trend for the oval shape:
once identified the longitudinal north-south axis, on ground floor, could be set
the transverse axis, at least to the edge of arena.
Once identified principal axes on the ground, you could finally proceed with
tracing the perimeter of arena, probably using simple ropes and stakes to
mark the arcs. In these early stages the distances were still contained and the
surface of arena certainly always flat.
The process of tracking, unable regardless of the main facade, we hypothe-
size could proceed by tracking the outer perimeter as an “offset” of curves of
arena. This phase was certainly more complex having to bring the curve of
perimeter on not horizontal ground.
Only at this point it was possible to divide the outer wire of facade in a finite
number of equal parts. Extending the lengths of surveyed radial walls, until
they cross the external facade, it has been able to find a measure that divided
exactly into 72 equal parts the front of amphitheater.
Durres amphitheater has an arena 59,70 m long and 40,74 m wide. A cavea
with a width of 28.45 m that lead to a total size of 116,60 to 97.64 m.
The cloud of points obtained by scanning has also allowed a detailed analysis of various sections and elevations above all of the parts of monument where the cavea is still intact because hilltown. This allowed us to check the constancy of cavea’s slope, confirming its constant width.

4. Survey as basic knowledge for urban planning, architectural restoration and archaeological excavation (PG)
Assumption of particular interest to every survey operation that can be defined really effective, is that these operations can support a lot of interdisciplinary studies about the object of survey.
Surveying and cataloging made for each building on the amphitheater urban context became, in fact, the knowledge and operational base of any subsequent planning operations related to the Recovery Plan of Durres Amphitheater, meaning, of course, the term “survey” is not simple measurement operations but a large and open knowledge system, extended to topics often highly interdisciplinary.
Each operation for safety and restoration of some parts of it, has been evaluated on the basis of geometric survey on architectural scale of the amphitheater, which has allowed to identify in a precise way areas that needed more urgent action, on the one hand, more accurate one, on the other.
Considerations on the original geometry of monument, made possible thanks to survey conducted with precision integrated methods, made it possible to direct priorities of new excavations, in addition to direct correct location.
In this sense, due to considerations summarized below, the survey even in this case was, and always is, how the essential cognitive base for any operation on a context or an artifact, which can actually be defined as appropriate with the characteristics of object, emerging from an in-depth reading and critical analysis of data collected during the survey.

Notes

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