

THE LASER SCANNER ANALYSIS AND MORFOLOGICAL TRANSFORMATION OF ENVIRONMENTAL ANTHROPIZED SITES: THE CASE STUDY OF GOVERNOLO'S ANCIENT DAMS

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ABSTRACT:

The survey with laser scanner is having one always greater spread in more different field of survey that they go from the system survey, architectonic, and of the territory; in particular within territory the possible applications go from the survey in excavation zone to that one in zone interested of landslide. The work here introduced show as the earthling laser, if opportunely managed, can let the survey of zones of particular interest is territorial is architectonic and it can be used as support of the programming of recovery and conservation intervention in the aforesaid zone. In this case it is proceeded at the survey, with laser scanner and traditional topographic survey, of the ancient dams of the river Mincio in Governolo (MN) and the surrounding basin. It is then experimented: the acquisition techniques with laser scanner of territorial and architectonic elements, the modality of elaboration of the data for the generation of digital terrain models (DTM), the possibility of interaction between traditional techniques of survey and the survey whit laser scanner. The research, considering the various aspects that they go: the use of software, the field survey, until the possible final analysis, is aimed to the definition of one possible way that go to reach all the various aspect and the various problematic that is meet: in the acquisition, in the use and in the elaboration of the data.

1. INTRODUCTION

The human hand creates its works from the inert matter, exactly second the same rules forms them with which the nature creates the own ones. Every human realization, between which the architecture, it is the result of a precise, aware and determined thought of its scope, than it is asserted fighting against the goals of the usefulness, of the matter and of the technique. To return to this precise thought in the terms of the survey involves the intention to know quantitatively the architecture and demands to understand what agrees for information. It can be spoken in a generalized manner about knowledge, but it can also be concentrated on what in the research it means a cognitive progress, conceived like the approaching to one prefixed scope, as an example the knowledge of the architecture through its measure (the survey) and its representation. That that ideally it wants from science through the knowledge is an exact representation-description of the fundamental aspects, deeply interconnected of the real one. The architectures are one of the traces that the man leaves in the space, traces whom they are before thoughts and then executed. Knowing passes for several the stages of the analysis, in attended of a synthesis that only very rarely comes true. In fact it is rarest that the knowledge analytics of the single aspects, scientific, aesthetic, ethical, catches up one unitary synthesis. The ancient dam of Governolo (fig. 1), as an example, are a typical case in which various disciplines they converge in order

The research has been realized by an agreement of research between the Municipality of Roncoferraro (Mantova, Italy) and the Polytechnic of Milan – Regional Pole of Mantova to complete an analysis that you carry to one define synthesis of several the aspects of the territory. Also in this case a unitary synthesis is not caught up because every science correlates to the other but conserve own the intrinsic autonomy. That does not remove that the scope of the knowledge of the system machine-architecture-environment in its aspects of the matter, historical, and geometric, catches up an elevated level, than ulterior developments of the knowledge legacies to the effective monumental complex recovery, will be able ulteriorly to elevate

or, to the contrary, to place in argument and debit for uncertain which already was given for acquired and sure.



Figure 1. The ancient dams of Governolo

Some property of this knowledge, than them are peculiar, are but notes: it puts into effect its particular characteristics making resorted to the amount, than it is established on the quality and the amount is always of one quality. And here the measurement enters in game, operation that associates to the quality the amount. The progress of science is emphasized diminishing of the uncertainty of the measures and of the increase in the number of quality quantified through the measures. To the time of Galileo these had uncertainty much greater one that not today, but the measured largeness were also in remarkably smaller number. In the dam of Governolo for the predisposed methodology of survey appears true as the increase of the number of the measures (quantified quality) and the lessening of the uncertainties of the coordinates of the points, due to the new instruments, put in extension morphologic contexts and transformations that they do not have a logical explanation but simply depend on the unavoidable progression of the time. The survey acts in this case like bearer of the state of fact, pure acquaintance through the representation.

2. THE SURVEY AND THE REPRESENTATION OF THE DAM OF GOVERNOLO

The different dimension spaces them of the survey involves various methodologies, aimed solutions, instruments adapts to you. In the representation of the territory, than the cartography very it supports and in which planimetry is privileged in a generalized manner, to the contrary in the architecture all and the three dimensions space them (X, Y, Z) have one importance in equivalent kind. The measure instruments adopt must be able to allow one adequate knowledge to you in the within 3D and therefore it is rerun more and more frequently to a survey and to an analysis of the constructed one by means of use it of systems LIDAR. With such instrumentation the study of the architecture and the territory that encircles it, nowadays effectively produces one three-dimensional real representation (3D). It is just in the particular location of the dam, considered like not separate architectonic element from its localization of the environment that such induces to one simultaneous study of the territory meant like anthropic place and constructed place. In this the context and the structure of the dam like architectonic door to the water, today lose its natural function, approval the movement of the river bed of the Mincio river, in order to become in the intentions of the proposing subjects the recovery, a place to museum in which the interpretation of the machine dam its is allowed in all leaves. The base of the study of the representation must hold account that in the complex of the dam dimensions, volumes and integrations between the parts exist and all that must be connected. This demands various methodologies and instrumentations of survey (direct, topographical and photogrammetric) that they must be interposed. From here the necessity of a net of general organization external to the dam put into effect more levels, extended to the complex of the House of the Concari in its inner determination, that it concurs of locate to the parts of the complex in an only system. Thickness, distances, volumes, courses, surface, are therefore reconstructed beginning from simple differences of space coordinates them. The survey methods cannot prescind (the dam as architecture it is the confirmation on the field), in spite of the sophistication of the technology put into effect them, from the banal methods of direct measure. That obligates to a classification of the methodologies that suggests endured an operating division that represent always because of the diversity of the architectures and that is of primary importance for the resolution of the survey. With this one agrees to resort to the traditional classification of the direct measures for the definition of the particular or integration of parts in shadow not covered from the successive typologies; indirect measures (traditional topographical survey and survey by laser scanner) in which the coordinates 3D of points are determined beginning from size observed of angular type or linear type. To these the obtained indirect measures for photogrammetric way join: the measure happens through the realization of the photography, opportunely dealt, in order to extract the necessary information to the successive analyses. With these methodologies the object comes crushed in with of such characteristic punctual data that their possession us door to the knowledge of the work in its entirety. That that there is of metric in the architecture is found or is sure deductible through the found one. It is a presumption that has one its base, many times totally acceptable in practical, above all nowadays with the employment of the laser scanner. It is this however one discreet methodology of real definition of, the discreet one in the resolution of the model, but also always made from with of points. This truth segmented for points of the survey makes to emerge all the problematic limitation of the method, and the onlooker is that while until much time it does

not make the problem he seemed to find its limit in the scarce number of the points actions to represent the complex of an architecture, today happens the contrary. Integration of such methodologies is mainly made to feel in the moment whose the photogrammetric survey are considered in order to generate digital orthoimage them of the foreheads. In this case the generation of the digital model them of raises to you can happen with several methods, from that traditional photogrammetric for automatic matching, to that topographical with stations no-prism (much slow one because it allows some thousand of points to the hour), to that laser scanner. The technology laser scanner generates cloud of points that, as a result recording and alignment to the system of the topographical net of main organization, they of the structure allows to the construction of the digital model. A new problem is born however: like managing and transforming the great numerosity of points in continuity through one adapted model.

2.1 The topographic networks

The topographic network (fig. 2) has been realized by means of total station Leica TCA2003, materializing the vertex second two typologies to us:

- the permanent vertex realizes with topographical nail fixtures to you on points considers you fixed;
- the passage vertex, realizes with stakes fixtures to you on the meadow of the river bed, uses you exclusively during the phase of survey in campaign.

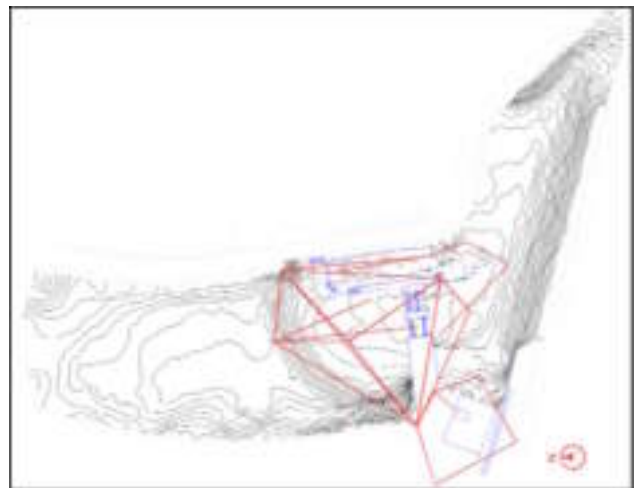


Figure 2. The topographic networks

To the main net, relative to the complex of the dam, an topographical hierarchy is connected second, the secondary net of the House of the Concari that is developed to the building externally. Subsequently from this it propagate the vertex of a detail net that is developed inner to the building on all the existing levels. These nets have been realized by means of total station Leica TCRA1103. The main net has been localized in the Italian Gauss-Boaga cartographic system by means of a survey GPS: two vertex have been frames to you in net IGM95 by means of instrumentation Trimble 4000 connects you to a bench mark IGM95-WGS84.

2.2 The topographic survey of photogrammetric and laser scanner support

In order to realize the successive phase of the photogrammetric survey, they have been materializes 637 points (fig. 3) to support by total station localized by Leica TCRA1103 and by

means of photogrammetric target on the entire complex of the dam and on the external fronts from the House of the Concari



Figure 3. The photogrammetric GCP of dam

Parallel for the survey of detail of the House of the Concari, in levels and sections they have been realized 1030 points of detail subdivided on the three levels of the construction.



Figure 4. Topographic points of detail of the House of Concari

2.3 The photogrammetric survey of the front dams and House of Concari

The survey of all the external fronts of the complex of the dam has been realized with camera Rollei DB44 metric having a digital back them PHASEONE from 4080x4076 pixel (resolution 9 micron). The camera produces a format RAW of image of approximately 32 MB for 16 million pixel with a depth of 48bit for channel, is subsequently converted in tiff with one dimension of approximately 48 MB. I use of this camera has happened with two optical calibrated from 40 and 80mm, each with just certified of calibration.

As far as the photogrammetric process it has been rerun to the simple rectification using for every orientation six GCP, for all those zones thought similar to a plan. For all the zones in which the three-dimensional variations they were not negligible have been used the digital orthoimage them 3D resorting to the laser scanner for the definition of model DSM. Altogether has been oriented in the two arrange 132 images in order to cover all the survey parts. The software used for the realization of the treatment of the images has been OrthoEngine Pci Geomatics: in the case of the simple rectification a DSM degenerated in a plan has been considered, while in the case of orthoimage it has been rerun to the DSM of the laser scanner.

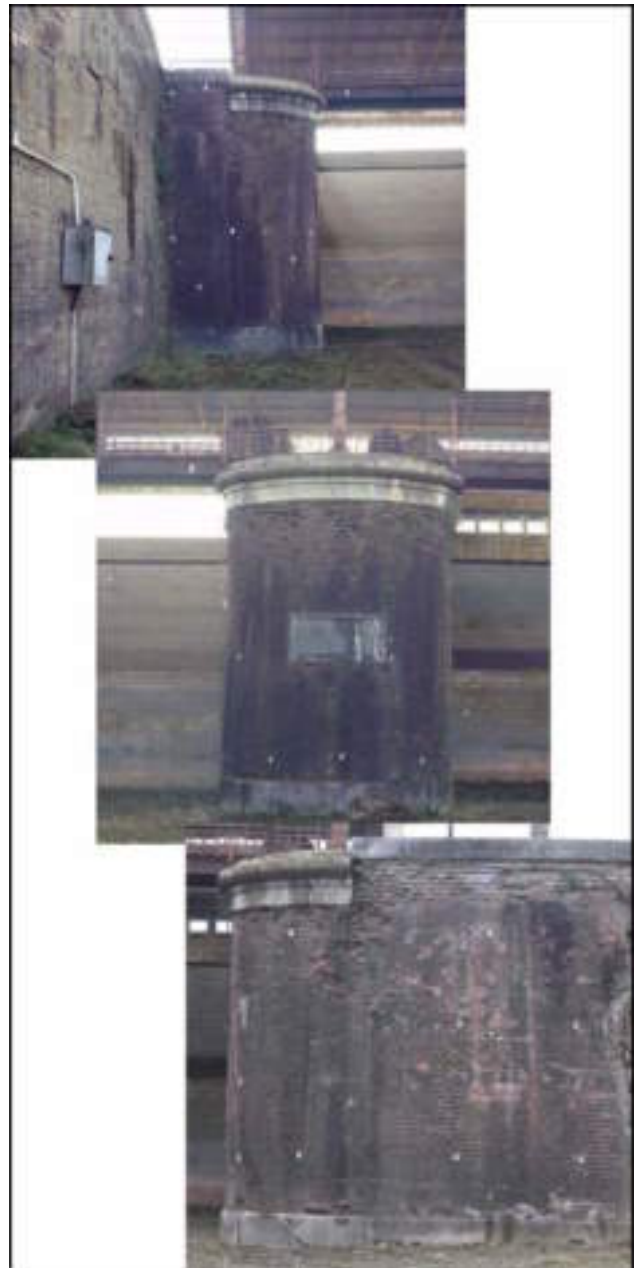


Figure 5. The photogrammetric images realized by Rollei DB44-Metric with PhaseOne digital back (16 milion of pixel)

The complex of the dam has been therefore subdivided in homogenous zones of representation for the successive phase of the mosaic of the single features and subsequently inserted in the system of reference of the main net.

2.4 The Laser Scanner survey

The survey has been realized using the Laser Scanner Leica HDS 3000 executing scansions on all the parts of the complex with one resolution on the object of a point every one cmq (fig. 6-8). The several scansions have been aligned for zones and recorded by means of use it of the target plates Leica, finds to you to leave of vertex of the secondary net by means of station total TCRA 1103. Altogether the cloud of the complex and the land of the valley surrounding is constituted from 20.6 milion (20636796) of points.



Figure 6. The survey with the Laser Scanner Leica HDS 3000



Figure 7. The cloud points: central zone of the dam, 3D view



Figure 8. The cloud points: front of central zone of the dam

The points find to you with the laser scanner are use you for:

- to generate models DSM for the production of the orthoimage of the fronts;
- to extract the vertical and horizontal profiles of the complex of the dam, for one representation to nominal scale 1:50.

The profiles have been subsequently quoted and overlapped to the representation raster of the digital fronts them.

3. THE REPRESENTATION OF THE CONSTRUCTED ONE: THE LEVELS, THE FRONTS AND THE SECTIONS

In order to represent in continuous way the House of the Concari (fig. 10-13) they have been realized to the several levels by means of the integration defined to paragraph 2. between the direct survey and the topographical survey.

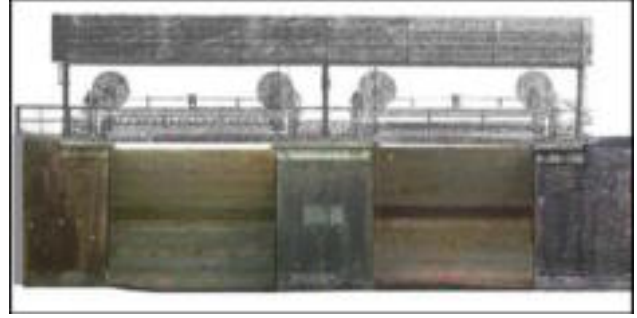


Figure 9. The mosaic realized with orthoimage and laser scanner DSM

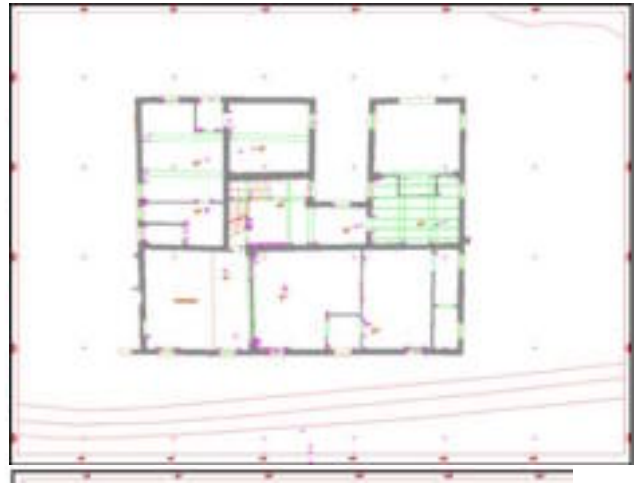


Figure 10. The House of Concari, the second level



Figure 11. The House of Concari, vertical section

Geometry and the absolute of main system is realized for points 3D surveyed in every room to the aim to guarantee the correct planimetric representation (survey of the vertex of room), while the detail has been carried out with instrumentation portable laser (DISTO) or manual instrumentation. At the same time also the inner sections have been framed and surveyed directly with topographical instrumentation, above all in the inaccessible zones for the collapse of structures.

The external fronts have been realize to you by means of rectified images to leave from the photogrammetric survey and successive vectorialisation with location of the macrozones of degradation, in many cases have been maintained the double

representation raster-vector for one corrected interpretation of the manufactory.



Figure 12. The House of Concari, the west front



Figure 13. The House of Concari, the south front

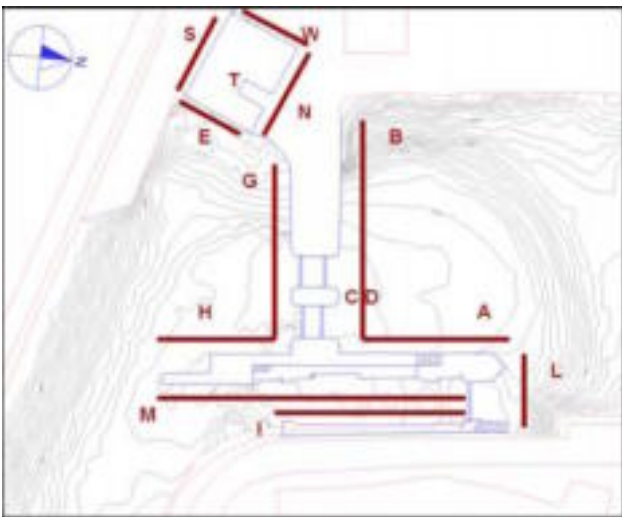


Figure 14. The complex of dams, mosaic of fronts

In the representation of the complex of the dam (fig. 14) it has been chosen to represent like main element the fronts of masonries in tile realized for rectification or for digital orthoimages them, inserting quoted the vertical and horizontal profiles it gains from clouds laser to you scanner and adding the vectorialisation. Also in this case mapping of the macrozones of degradation has been realized (fig. 15-16).

4. THE MORPHOLOGICAL REPRESENTATION OF THE VALLEY OF GOVERNOLO

The survey of the land that constitutes the valley that served to slow down the speed of passage of the structure has been found through the laser scanner as a result of cut of the existing vegetation. In this way it has been generated a model 3D of the valley, represented by contour lines, from which the necessary information of the land to the future phase of plan have been extracted. The Municipality previews in fact the construction of one natural theatre whose the scene will be constituted from masonries of the dam.

5. CONCLUSIONS

In the field of three-dimensional the photogrammetry interacts more and more with the techniques laser scanner for the attainment of the final outcome, the knowledge and the representation 3D of the objects. The digital photogrammetry them concurs a continuous representation of the object, but it above all places some limitations in the economy of the time and the costs, in phase of realization. The system based on the laser scanner, clearly faster regarding the previous one, creates the image of the model through also million points, but it is a representation that cannot immediately be used. It is only from the research and the analysis of the possible interaction of the methods that will be possible to arrive to of turns out useful to you that they exceed the existing dichotomy between the models (laser-photogrammetric) more and more defined in the complex measured space and from the other part the professional operator (accustoms to you to simple shapes of representation) that they ask simple and comprehensible models that are directly usable in the searches. The technique in this field must be moved from the world of the simple representation like marketing operation (virtual reality) to a realized objective representation 3D not for primitive, but for objects surveyed and measurable.

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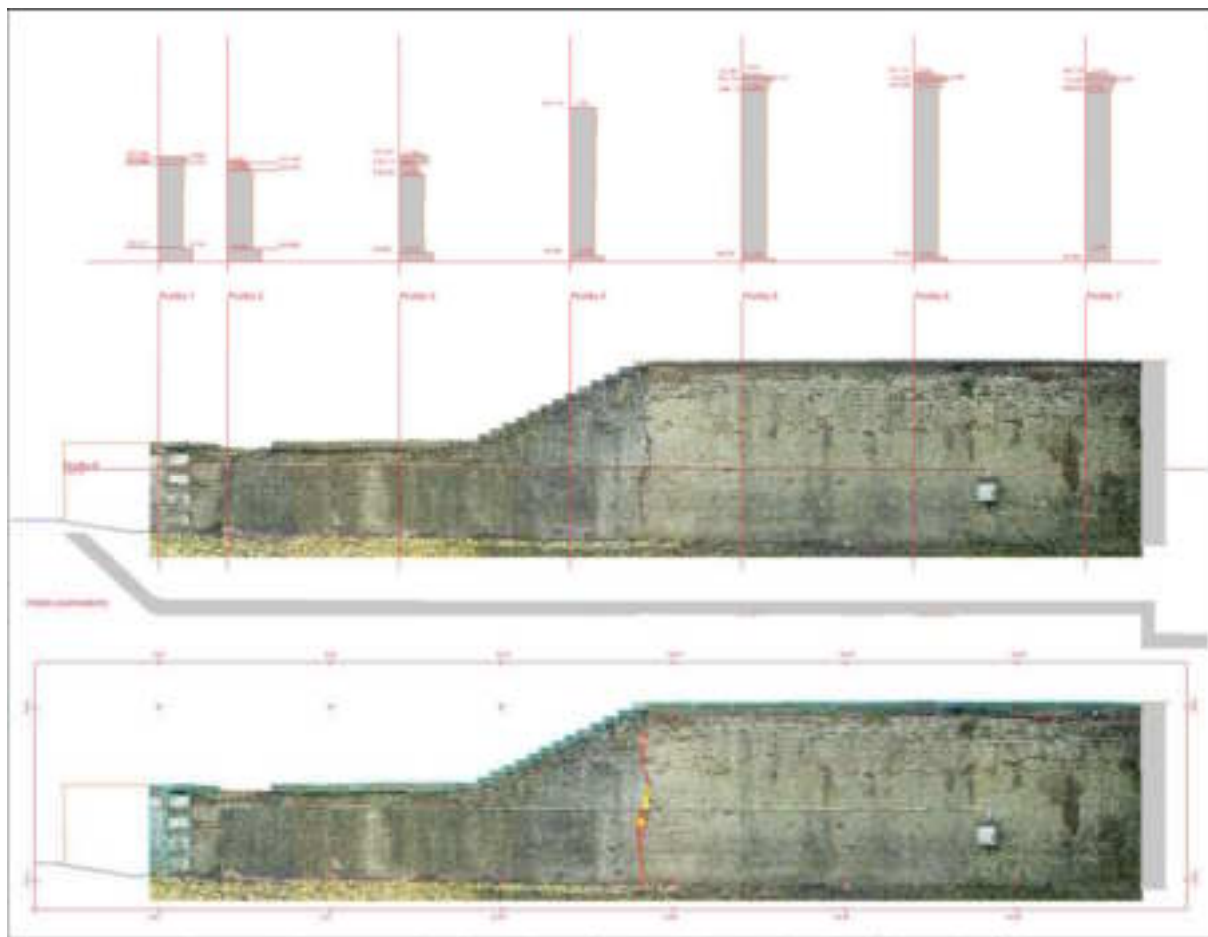


Figure 15. The prospect A in the complex of dam, orthoimage, vertical and horizontal profiles

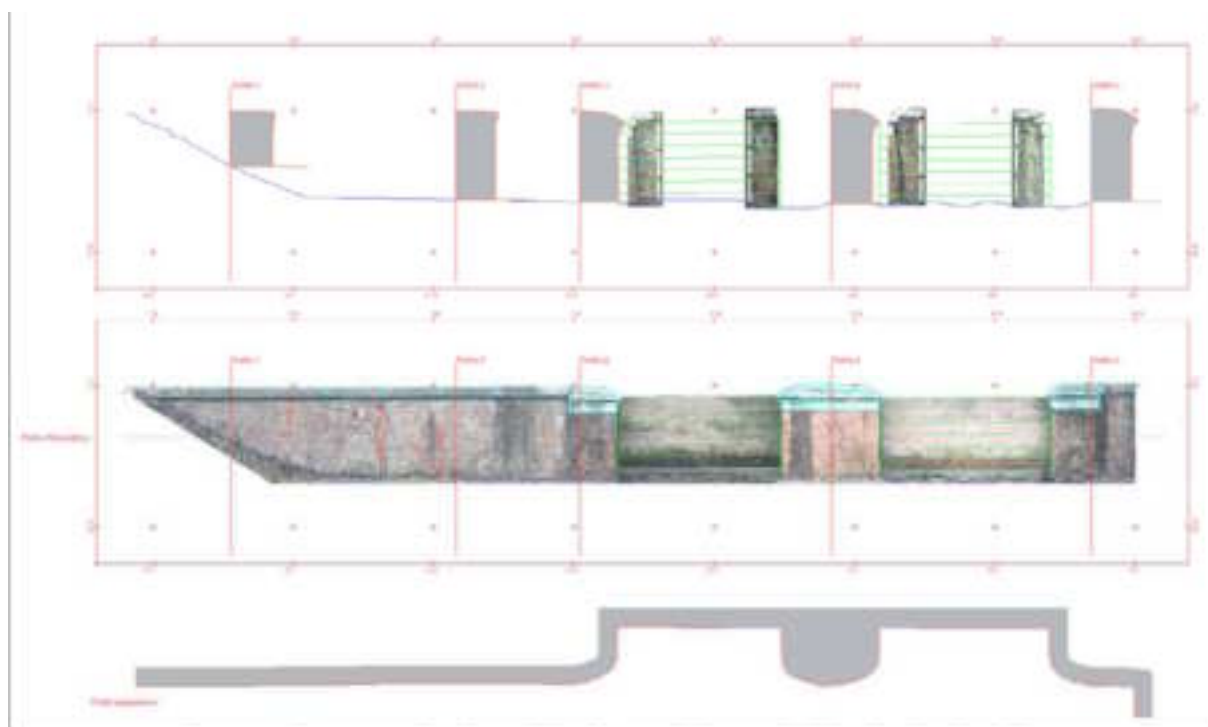


Figure 16. The prospect G in the complex of dam, orthoimage, vertical and horizontal profiles