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Marco Giorgio BEVILACQUA, Denise ULIVIERI (Eds.)

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Digital survey and architectural representation of a Genoese tower for the Museum of the city and territory of Galata

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Abstract

Galata, one of the oldest districts in Istanbul, still shows a historical and multi-layered urban texture. In 2019, within the "Urban Facade-Istanbul Waterfront" international workshop, a 3D laser scanner survey of Galata's city walls was carried out. The raw data therein collected became the basis for a thesis in Architecture, as part of a joint research (Politecnico di Torino, Özyeğin University, Università di Firenze) on the fortified systems in the Mediterranean area. The multidisciplinary research comprised the historical study of the transformation of the urban tissue in the considered area, and the relationships between the city, the walls, and the towers. We processed the digital survey with the aim of realizing 3D models and orthophotos of a sector of the walls characterized by a Genoese semicircular tower, which today is abandoned. The final drawings are aimed at recognizing the building's transformations, the different materials, and the relationship between the monument and the context. The research also outlined the damages, underlining the urgency of restoration works.

Keywords: digital survey, 3D modeling and representation, open-air museum, Galata.

1. Introduction

Galata, one of the oldest districts in Istanbul, still shows an historical and multi-layered urban texture. In 2019, within the "Urban Facade-Istanbul Waterfront" international workshop, (Özyeğin University), a team led by G. Verdiani carried out a 3D laser scanner survey of Galata's city walls. The raw data therein collected became the basis for Doruk Peker's thesis in Science of Architecture at Politecnico di Torino, supervisors R. Spallone, A. Camiz, M. Vitali, as part of a joint research (Politecnico di Torino, Özyeğin University, Università di Firenze) on the fortified systems in the Mediterranean area. The multidisciplinary research comprised the historical study of the transformation of the urban tissue in the considered area, the relationships between the city and the walls, and the construction of the walls and the towers (1). Then, the digital survey has been assumed and processed with the aim to realize 3D models and orthophotos of a sector of the walls characterized by a Genoese semicircular tower today in state of abandon and obsolescence. The detailed drawings testified the superfetation occurred in the building as well as the constructive materials and unified the different information for an integrated communication declaring the data accuracy through a codified system of graphic conventions. The final plans, elevations, and sections, aimed at recognizing the building's transformations, the different materials, and the relationship between the monument and the context. The research also outlined the damages, underlined the urgency of restoration works and suggested the design of an open-air museum, entitled "Museum of the city and territory of Galata".

2. Urban Transformations of Galata and the walls

The topographical knowledge of Constantinople is generally fragmentary, but the formation process of Pera, also referred as *Regio tertiadecima* in the *Notitia Urbis Constantinopolitana*, is barely known. The Ottoman period of Galata has been widely studied and documented (Cuneo, 1987), but for the earlier phases, besides Dallegio D'Alessio's (1946) detailed reconstruction, the research of Paolo Cuneo (1983-1987) and the recent studies on the Genoese period (Saĝlam, 2018), the knowledge about this part of the city is almost a *tabula rasa*. Wolfgang Müller (1993) published plans where the only topographic feature in Byzantine Pera are the Genoese walls, even the most recent plans of the Byzantine phase of the Polis (Dewing, 2015), show only the Galata Tower, which is known to have been built by the Genoese administration in 1348.

Within this knowledge of the Topography of Pera (today Karaköy), we attempted the application of the Caniggian (Caniggia, 1979) morphological analysis of the cyclical inversion of centers and limits, in strict correlation with the opposite shore of the Kryson Keras, where the growth process is known from sources and archaeological evidences. This comparative approach derived from the diachronic evolution of Byzantium and its Roman transformations, with particular focus on the changing positions of city walls and the different central *forum*, the parallel hypothetical evolution of Pera, starting from the first Megarean colony, through two subsequent Roman additions (Constantine/Honorius and Justinian). The results of this hypothetical diachronic reconstruction were confirmed by the scarce documentary sources, the archaeological evidence of Roman hydraulic infrastructures, as well as the results of the orientation analysis of the contemporary urban tissue, establishing, therefore, a topographical

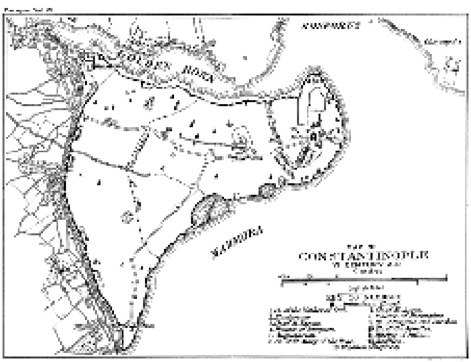

Fig. 1 - Map of Constantinople in the VI century, Procopius. The Anecdota or Secret History. Translated by H. B. Dewing. Loeb Classical Library 290. Cambridge, MA: Harvard University Press, 1935, p. 361

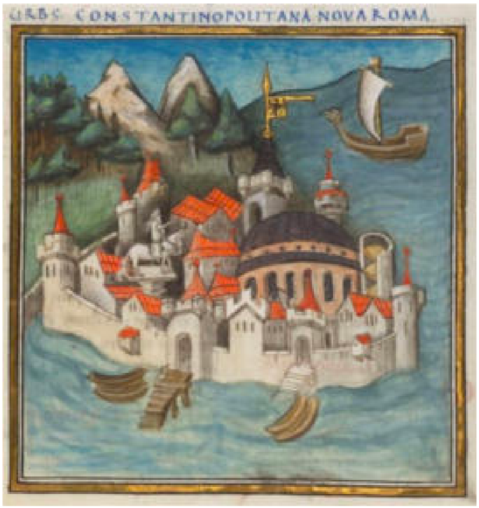

Fig. 2 - Urbs Constantinopolitana. Nova Roma, MS canon. misc. 378 f. 84r, 1436 (© Bodleian Libraries, University of Oxford)

Fig. 3 - Liber insularum Archipelagi, Cristoforo Buondelmonti, 1470 ca. (Biblioteca Medicea Laurenziana, MS. Plur. 29, 25)

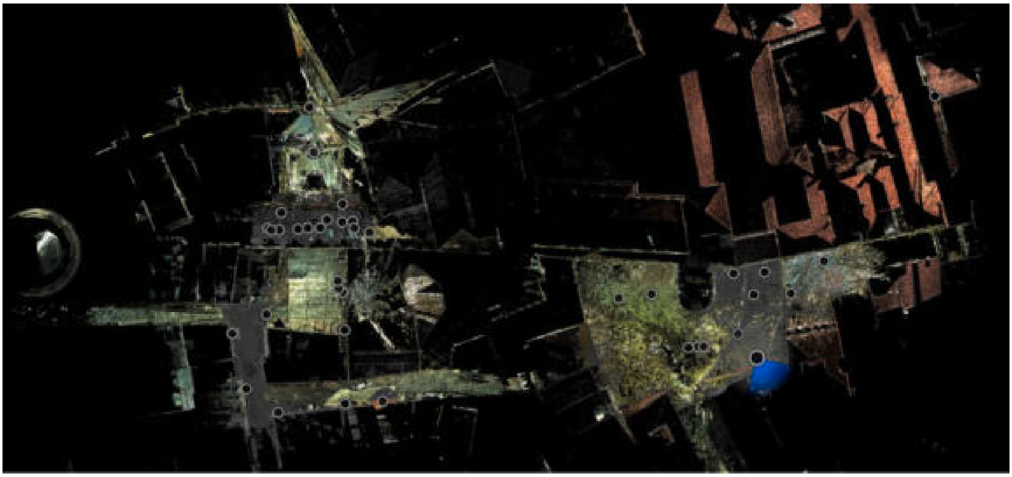

Fig. 4- The whole set of scan stations from a top orthographic view, on the left of the Galata Tower

plan localizing the main features of the Roman and Byzantine settlement of Pera, Sykai, Galata.

3. Digital Survey of the fortifications

Documenting a fragmented architecture needs accuracy, accessibility, and correct positioning. Each piece of built history needs a proper level of details to allow efficient reading, the most complete coverage of all its parts, and the certainty of having it well aligned in the present urban tissue. The digital survey of the towers and their surrounding areas was based on one single 3D Laser Scanner unit (3DLS), with a working range up to the distance of 300 meters. The model in use was a well-known and not that recent unit, a Leica Geosystems ScanStation C10, a 3DLS based on 'time of flight' measurement (Bini & Bertocci, 2012). It has the features of gathering points in a panoramic field of 360° on the horizontal and 270° on the vertical. Each gathered point got a measurement accuracy of about four millimeters at ten meters on standard reflective materials (Bianchi et al. 2016).

All the scanning work was planned to obtain a point cloud with a level of definition between the architectural and the urban scale. For this, the settings of the 3DLS and its positioning were set with the aim of producing a grid of about one point each centimeter at ten meters of distance for almost each scan station. The C10 unit has also the feature of taking panoramic pictures for coloring the resulting point cloud, with its internal camera taking a sequence of shots immediately used to remap the colors of the gathered point cloud without causing any parallax error because its position and field of view are exactly the same of the laser measurement system. This function, even if time-consuming (about four minutes for each scan station, which means adding an equal time to the point-cloud scanning itself), is very useful in the documentation of the remains of these fortifications, making it easier to recognize the complex stratigraphy of the phases, from the original parts to the various reuses with all their weird elements, describing with plenty of details in a complete 3D model all the masonry works, iron elements, cracks, holes, fallen pieces. For covering all the areas accessible in safety conditions, a total of 40 scans were operated in the turn of one afternoon. The scanner positioning was planned in a classic logic of having sufficient overlapping between scanned areas. The intervention was brought on in the main space around the first tower (for a period occupied by industrial uses); then with a specific intervention for the second tower (in extremely bad conditions and not directly accessible) which was surveyed from the distance positioning the scanner along the nearby roads and lots; in the end, a large portion of masonry work from the original walls was surveyed from the inside of recent building growth against the fortification and now used as a restaurant. The results were then quite fragmentary, but it was possible to align them in a single model exploiting the long-range capability of the scanner and targeting quite far elements like the Galata Tower itself and various tall buildings and roofs. The area with the first tower was covered with 14 scans, the area with the second tower was covered with 10 scans, the portion of walls in the restaurant was covered with 15 scans, and one extra scan was taken from the roofs in a nearby area to allow a more efficient alignment of all the sectors. The bad conditions of the interiors of the towers blocked access for taking scans from the inside, thus the various openings allowed to gather a certain amount of metric information for estimating the thickness of the walls and the main aspects of the masonry work

4. The Genoese tower: Artifact reading and raw data integration

The tower on which the work of analysis and graphic interpretation focused is the second tower on the surveyed portion of the wall, which extends southwest of the Galata Tower.

The U-shaped tower measures approximately 9.80 x 7.70 m in plan and about 16 m in height: the circular facade faces a courtyard to the north, which is currently used as a parking lot; to the south, it passes the city walls, which in turn are adjacent to St. Peter's Church.

Direct observation clearly shows how the building is founded on the rock (the ground level has decreased over time, gradually uncovering the foundations, which to this day emerge above ground), and the numerous traces of artifacts and plaster suggest the presence of buildings that were built over time adjacent to the tower and subsequently collapsed or demolished. Today, between these pre-existing buildings, a warehouse structure remains, adjacent to the southwestern facade of the tower. The building is currently empty and unused.

Due to uses unsuitable for the building's function, architectural elements have been added over time that is not appropriate to the original nature of the building and its structural characteristics (holes, intermediate floors, facade cladding, etc.), which have resulted in a general weakening of the structure: cracks and projecting girders are distributed on all exterior wall surfaces. At present, the tower also lacks a roof, which considerably accelerates its deterioration process.

In an example such as this, interpretation of the raw data is particularly important, since the information derived from each survey method is incomplete and requires significant work of interpretation and integration.

The laser scanner survey comprehensively rendered all the exterior surfaces of the artifact, but for numerous reasons, it was not possible to carry it out on the interior of the structure as well: for the interior parts, the restitution work had to make use of the information derived from direct survey and observation, since the interior floors are missing. The drawings were made from thin,

Fig. 5 - View of Tower one from the point cloud, colored map mode, panoramic view

horizontal, and vertical point cloud slices: the information from these slices was supplemented by direct surveys of interiors. The elevations were drawn thanks to the photoplanes obtained by projecting the point cloud on planes parallel to the main layout of each elevation.

The entire data integration and restitution work were done in the AutoCAD environment, after appropriate operations necessary to manage the point clouds in the Recap environment.

5. Graphic restitution

The graphic restitution of the digital survey aims to constitute a documentary basis useful as a testimony to the state of conservation of the remains and as a means for the elaboration of conservation and enhancement proposals. Hence the choice of the scale of reduction is 1:50, a scale that entails the representation of the textures of materials, door and window frames (when present), and the main signs of degradation related to structures (fractures, lacunae,…), materials (washouts, detachments,…), and vegetation infestation.

The choice of horizontal section planes was guided by the recognition of the openings, including the filled ones, and the placement of the thin interior slabs, directly surveyed due to the impossibility of scanning the interiors. Six plans, at different levels, were considered adequate to provide a comprehensive representation of the artifact. Four vertical sections were considered useful for the representation of the main masonry discontinuities and back elevations. These are the drawings in which the integration of survey techniques proved most effective, allowing the geometric and material characteristics of the interiors to be defined.

Finally, the three elevations, were drawn based on the ortho-photoplanes obtained from the point cloud and supplemented with numerous detailed eidotypes performed on-site and directly measured.

Therefore, the drawings condense the peculiarities of geometric, architectural, and thematic surveying, the latter dedicated to the representation of materials. For this representation, conventional hatches prescribed by the graphic standards (UNI 3972/1981 and UNI ISO 128-50) have been selected and integrated with those consolidated in international manuals.

In conclusion, the detailed drawings testify to the stratifications that affected the building as well as the construction materials.

The drawings unify the different information for an integrated communication declaring the data accuracy through a codified system of graphic conventions. The final plans, elevations, and cross sections achieve the goal of recognizing the

Fig. 6- The scanner unit at work from the buildings around tower two

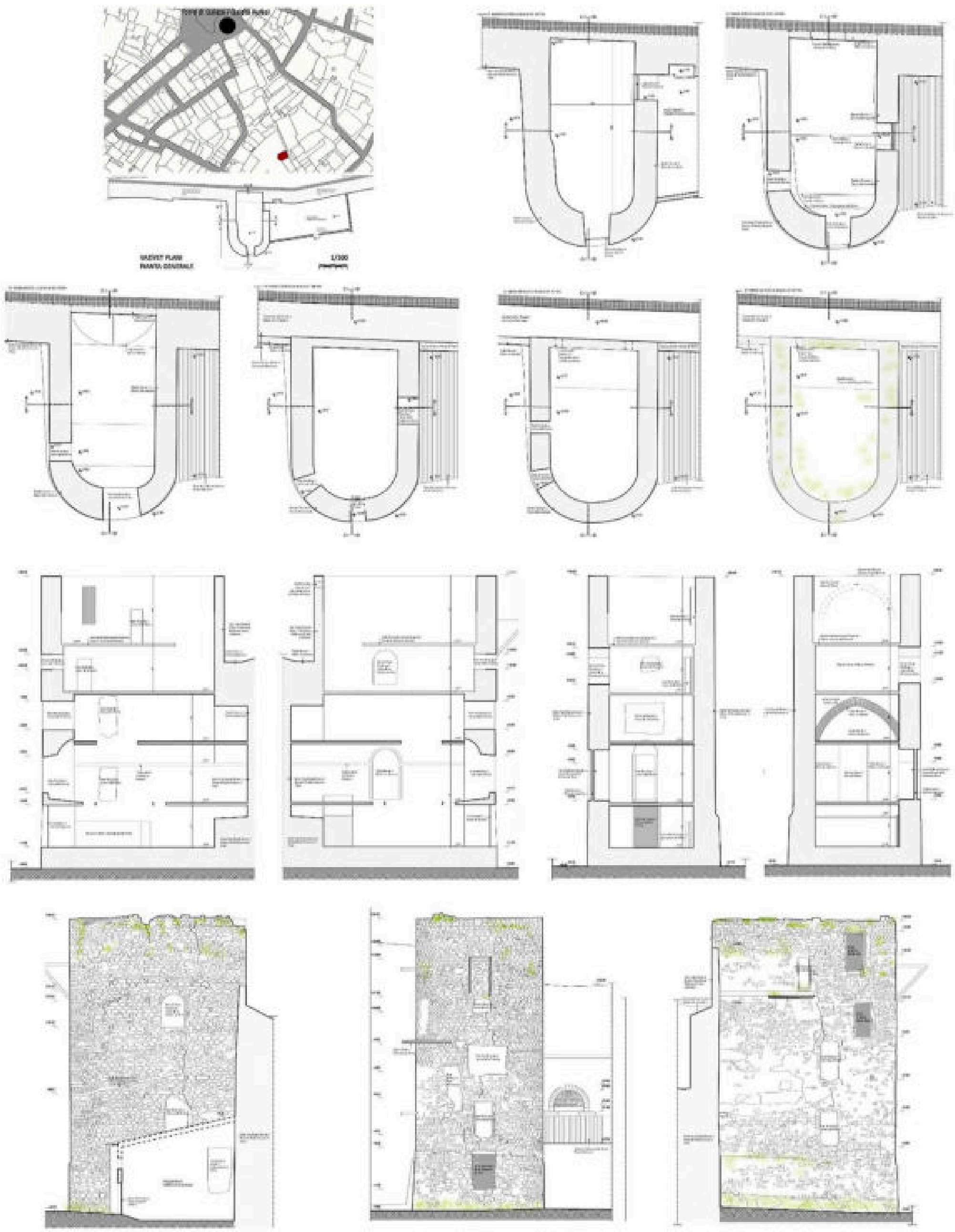

Fig. 7- Digital drawings of the Genoese tower. Plan view, plans, cross sections, and elevations, original scale 1:50 (editing by Doruk Peker)

building's transformations, the different materials, and the relationship between the monument and the context. They also outlined the damages, underlining the urgency of restoration works aimed at the design of an open-air museum, entitled "Museum of the city and territory of Galata".

6. Conclusion

A neglected building will always benefit from a survey intervention, its documentation fixes the conditions and allows an easy sharing of a massive amount of data. Even in case of full loss, the detailed drawings may allow at least a virtual reconstruction of the built heritage, otherwise completely lost. Once more, the use and sharing of digital documentation allows many different competencies and uses to be applied to the architecture, promoting options for recovery and new ideas. The accurate description of the masonry works and of the shapes of architecture allows for a better understanding of periods and the logic of the original system, adding useful clues for a better knowledge of the building. In the case of the remains of the walls of Istanbul and their towers, the value of the constructions themselves is amplified by the high risk of loss, while at the same time, their specificity and unicity are elements worth to be enhanced and exploited in the overall recovery of the Galata neighborhood which is otherwise at risk of being gradually converted into an anonymous and a poorly 'globalized' collection of restaurants and temporary residence activities (Verdiani et al. 2019).

Notes

(1) While the research is the result of the collaboration between the authors, paragraphs 1 and 6 were written by all authors, paragraph 2 by A. Camiz, paragraph 3 by G. Verdiani, paragraph 4 by M. Vitali, paragraph 5 by R. Spallone.

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