

Digital models for the virtual reconstruction and the representation of the existing: the city gates of Turin

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# 6 DEFENSIVE ARCHITECTURE OF THE MEDITERRANEAN XV to XVIII Centuries

Ángel Benigno GONZÁLEZ AVILÉS (Ed.)







DEFENSIVE ARCHITECTURE OF THE MEDITERRANEAN  
XV TO XVIII CENTURIES  
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XV TO XVIII CENTURIES  
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Ángel Benigno González Avilés  
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## Note

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## Preface

The FORTMED Congress celebrates its third edition in October 2017 in Alicante. From its beginning in Valencia and its later jump to Florence, the interest for the investigation on the fortified heritage has only been growing, as much in extension as in depth. After the launch of this congress by the research group of the Polytechnic University of Valencia "Architectural Surveys", with extensive experience in the study of fortified towers of the Spanish Mediterranean, led by Pablo Rodríguez-Navarro with the collaboration of Teresa Gil Piqueras, the witness was collected by Giorgio Verdiani, Scientific Director of the Architectural Information Technology Lab (LIA), Università degli Studi di Firenze. Both editions had a large forum of researchers of different nationalities who shared their experiences in the study and intervention in fortified sets of the Modern Age. Historians, architects, engineers, archaeologists, geographers, cartographers and researchers from multiple disciplines exposed the fruits of their research, the lines they are designing for the near future, and a set of intervention projects in the fortified heritage.

In this third edition of the congress, the original idea has been to gather more inclusive, real and actualized data leading us to the level where research regarding this matter should be more readily available in the 21st century. The theme of the conference has been focused on western Mediterranean fortifications (Spain, France, Italy, Malta, Croatia, Albania, Greece, Turkey, Cyprus, Tunisia, Algeria and Morocco) dating from the 15th to the 18th centuries, including the rest of Mediterranean countries and the fortifications of this era that were built overseas (Cuba, Puerto Rico, Philippines, Panama, etc.). In this edition of Alicante has opted for a continuity in the thematic blocks, although some minor modifications have been introduced. Mainly the "Port and Fortification" line, due to the special interest of the Technology and Sustainability research group of the University of Alicante in the identification of the characteristics that distinguish the fortified set of the city of Alicante and the island of Tabarca. The debate produced by the different interventions of experts in fortified groups of coasts, and especially of the Mediterranean coast, is expected to be a clarifier of the proper elements of the Alicante heritage. The comparative analysis with other fortified settlements of the XVI-XVIII centuries, in their genesis and evolution, will help to contribute new values to the historical knowledge of the fortified heritage, and the way in which the intervention projects should be undertaken, both in their architectural conception, as well as of the uses that could be introduced and specific intervention techniques.

We hope that this new edition of the FORTMED congress will strengthen the bonds established between different researchers for a more effective collaboration in the knowledge, maintenance and intervention in the fortification heritage complexes. The interdisciplinarity that should be promoted in the master plans from the public administrations will certainly be reinforced with this type of events. The exchange of experiences, research results, and difficulties in interpreting the intrinsic values of each heritage element will undoubtedly be enriching. This is shown in many of the papers and communications presented at the congress, and included in these two books. Dive into the contents of more than 120 published works, peer-reviewed by members of the Scientific Committee, is an incomparable experience of the complexity that entails entering the soul of these architectural ensembles. It is a living architecture, often in daily use for cultural activities, playful, archival, etc., with very close and complex relationships with the urban plot or the landscape. Accessibility problems are

critical in the design of intervention strategies that strongly support the recovery of these patrimonial elements. In this sense, performances such as the mechanized accesses of the stairs of the Farm in Toledo, the architects José Antonio Martínez Lapeña and Elías Torres, or the elements projected in the walls of Pamplona, deserving in 2012 of the prize Europa Nostra, are worthy objects of reflection and approaches that shed light on this difficult task. Some of the communications presented reflect on how to deal with accessibility issues in other towns, including Alicante, such as Santa Barbara Castle and San Fernando Castle.

I would like to end by thanking Pablo Rodríguez-Navarro, President of FORTMED, for all the help he has given us in the pleasant task of organizing this congress. Thanks to Giorgio Verdiani, FORTMED chair of the last edition in Florence. Special thanks to the Vice-Rectorate of research of the University of Alicante for its constant support in the organization of the congress, and in the funding of the papers of the invited researchers. Thanks also to the Manuel Peláez Foundation and the Vice-Rectorate of Campus and Technology for their help in funding this event.

Finally, I would like to express my gratitude to all the authors of this publication for the quality of their contributions, their attitude in regard to the adequacy of the reviews and their patience throughout the editing process and registration. I also extend my gratitude to the Scientific Committee and the Organizing Committee for their selfless dedication and professionalism. It has been a pleasure to share with you all this year of intense work for the third edition of FORTMED in Alicante to become a reality. Special thanks to Ángel Benigno González Avilés, Secretary of the Congress, and Isabel Pérez Millán, for their good work and generous dedication. To Maribel Serrano and Asun Sempere, managers of the Department of Architectural Constructions of the University of Alicante. And Mateo Aires, who has worked as an intern in the many issues related to the management of the congress. It has been a pleasure to share this adventure with you.

Víctor Echarri Iribarren  
FORTMED2017 Chair



## Digital models for the virtual reconstruction and the representation of the existing: the city gates of Turin

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### Abstract

This paper focuses on researches already undertaken and presented in this conference: starting from the work previously carried out for the setting up, at the urban scale, of a consistent database for the fortified walls of the city of Turin – which updates reading diagrams, maps, archival documents –, it intends to make thematic analysis aimed on the one hand to survey the “existing” and to critically read historical layers, on the other hand to digital reconstructions. In this regard, city gates constitute a homogeneous architectural 'category' that follow the complex transformation – by enlargements, overlays, reconnections – of the walls layout.

On the gates, we are organizing a collection of digital representations, uniformly designed and organized to test study approaches, operating methods, purposes and modes of the graphic communication: starting from the analysis and instrumental survey of the only well-preserved gate (*Porta Palatina*, I century AD) for the representation of the historical layers; to continue, in constant relation with sources, with virtual anastylosis.

**Keywords:** survey, representation, 3d modeling, virtual reconstruction.

### 1. Introduction

This contribution is inspired by a research already begun and presented in a recent edition of this conference (Vitali 2015): starting from a work on the management, at a urban scale, of a congruent database – that updates schemes, cartography, archival documents – related to the fortified wall of the city of Turin (Vitali 2015), it was thought, for a new phase of the research, to deepen the theme on the city gates. They – from the first Roman edition of the walls to the last events before the nineteenth-century dismantling – constitute a homogeneous ‘architectural category’ that followed the complex transformation, for subsequent enlargements and overlays, of the wall layout.

On these city gates is being organized, in collaboration with Roberta Spallone, a collection of digital representations, homogeneously conceived and organized to experiment different study approaches, operating methodologies, goals and modes of the graphic communication.

This research follows these guidelines and focuses – starting from the instrumental survey of the only well-preserved city gate (*Porta Palatina*, I century AD) – on graphic analysis, digital reconstruction and modelling as a basis for subsequent stages of study on historical stratifications, both at the architectural and urban scale of representation.



Fig. 1 – left: *Porta Palatina*, south front (2016); right: location of the gate in Turin today

## 2. The case study: *Porta Palatina* over the centuries

The *Porta Palatina* (*Principalis Sinistra*) is the only city gate that remains almost intact of the fortified walls, realized for *Julia Augusta Taurinorum* (the ancient Turin) in the 1<sup>st</sup> century AD. The four main city gates were very similar in shape and size: they were with a *cavedium*, developed around a central courtyard surrounded by high walls. This structure of the *Porta Palatina* today is only readable by some traces that allow to identify the main dimensions (about 11,2 x 12,2 meters) (Ratto 2015, p. 18). The gate, in brickwork, consists of a central body – about 20 meters long, with four openings (two for the carriage passage and two for the pedestrian walkway) and two overlapping orders of windows – and two polygonal towers with sixteen sides (about 22-25 meters high), divided into five levels marked by alternating arched windows. (Papotti 2003, p 259). Regarding the other gates, the *Porta Decumana*, very similar to the *Porta Palatina*, was incorporated over the centuries in the construction of the Acaia castle, which later became *Palazzo Madama* (Mercando 2003, p.40;

Ratto 2015, p.21). The *Porta Praetoria* (or *Segusina*), is clearly visible in mid-fifteenth century maps as the one by Caracha (“Augusta Taurinorum”, 1572. Archivio Storico della Città di Torino, Collezione Simeom, D 1) and the other one by Righettino (“Pianta prospettica di Torino con dedica a Carlo Emanuele I”, 1583, Archivio di Stato di Torino, Museo Storico), then definitely demolished, after some reconstructions, in 1585. Little is known about the *Porta Principalis Dextera* (or *Marmorea*) except that it was destroyed around 1660 (Mercando 2003, p.40): a Giuliano da Sangallo's drawing, for a long time referred to it, according to recent studies, "portrayed, instead, reinterpreting with some freedom, one of the other gates still intact at that time, probably the *Porta Palatina* " (Ratto 2015, p. 22).

Referring to the transformations of the *Porta Palatina* over the centuries, it is known that its towers were equipped with battlements in 1402 (Promis 1869, p. 209) and that a disc with the monogram of Christ was placed on the main wall in the protection of this and of any other

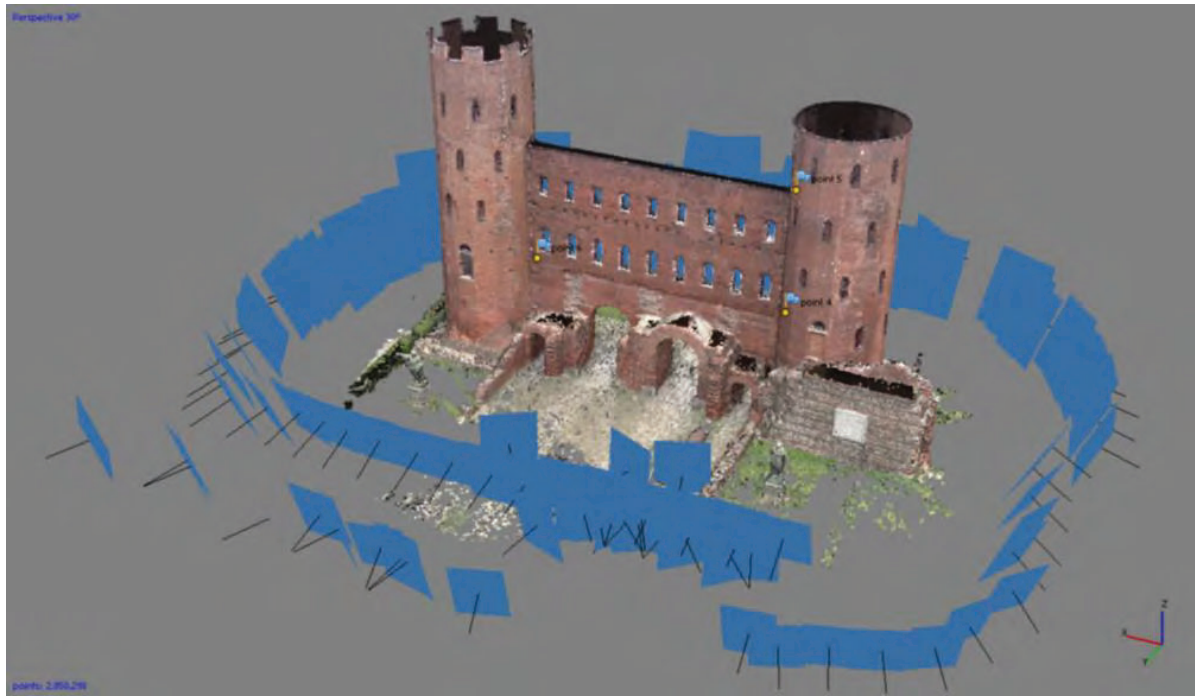


Fig. 2 – Alignment of photographic shots and creation of the *dense cloud* with Photoscan® software (author).

access to the City in 1519, in full Counter-Reformation (Promis 1869, p. 210). Despite the transformations of the surrounding urban fabric, the *Porta Palatina* kept its role unchanged – even if the only eastern opening was still existing – until the early 18th century. Saved by Antonio Bertola in 1706 (Pejrani Baricco 2015, p.34) from a destruction, the gate was given by Vittorio Amedeo II to the Municipality (Promis 1869, p.219) in 1724 that used the gate to establish the *Carceri Vicariali*, then only ‘feminine’ just to the accomplishment of the *Carceri Nuove* in 1872 (Papotti 2003, p.265). In 1860, a survey and a project of “restoration and re-modernization” was made by Gaetano Bortolotti, with insulation of the gate from the construction fabric to which it was attached. “Although not realized, the project was approved and became the basis for a long campaign of acquisitions and progressive demolitions” (Papotti 2003, p. 265). In 1864, the restoration of the monument was formally assigned to Promis. The project included the replacing the fifteenth-century battlements with new squared ones and the construction of a new school building – a smaller volume than the pre-existing to be built on the inside of the gate – to be invisible by those

observing the monument from the north; the façade was freely inspired by modules and decoration of the exterior facade. The building, completed in 1875, first hosted a drawing school and later (from 1778 to 1884) a musical high school (Papotti 2003, p. 270). A new restoration was carried out by Alfredo D’Andrade with the excavation that highlighted the square bases of the towers and part of the ancient pavement, the demolition of the Promis building and the reparation of the towers (1903-1915). The works were interrupted with the outbreak of the First World War, to resume only in 1935, when a new project for the Archaeological Zone surrounding the *Porta Principalis Sinistra* was promoted by the Municipality and finished in 1938, with the completion of the eastern tower, the realization of reinforced concrete ceiling to close the towers and the elimination of a stone frame wanted by Promis. The works were criticised for a long time just to the beginning of the Second World War. The gate, which fortunately was untouched by the bombings, was the subject of new restorations since 1946 and the entire archaeological area was reconsidered from those years with numerous resettlement projects





Fig. 3 –Orthomosaic of the north elevation of the Porta Palatina, produced starting from the texturized model using photoscan® (author).

(for brevity we will not treat this period): the definitive configuration of the Archaeological Park was achieved some years ago, with the project by Aimaro Isola, Giovanni Durbiano and Luca Reinerio (2003) (Baietto 2015).

## 2. The survey

Starting from the information presented here, the research project has focused on the instrumental survey in order to provide the necessary representations for the subsequent stages of graphical interpretation and analysis useful for the critical reading of the main transformation stages of the building. For this stage of the work, a photographic survey was carried out in order to make a photo-modelling with Photoscan® software. According to established practices in this operational field, an appropriate number of mid-size frames (106) were shot, and a dense cloud was created, which, cleaned and settled, shows about 2,850,000 points. The associated mesh model, constructed with 6,000,000 faces, was subsequently oriented and scaled into space

and textured for the realization of orthophotos useful for graphic analysis and three-dimensional modelling phases.

## 3. The graphical analysis

The next stage of the work focused on the graphic analysis and the representation of the north elevation based on the units of measure and the construction modules used for the architectural composition. In this regard, the work was closely related to a previous research developed by Kurent (Kurent, 1965) on the survey drawings made by Promis (Promis, 1869). The module used by Kurent for his graphic analysis refers to the particular type of brick used to make the gate, the *Lydica*, with standard measures of 44.39 cm (*cubitus*) x 29.57 cm (*pes*) x 7.47 (*palmus*): "the common measure for the dimensions mentioned is 1 *palmus*; the ratio of brick dimensions is 6: 4: 1." (Kurent 1965, p.39).

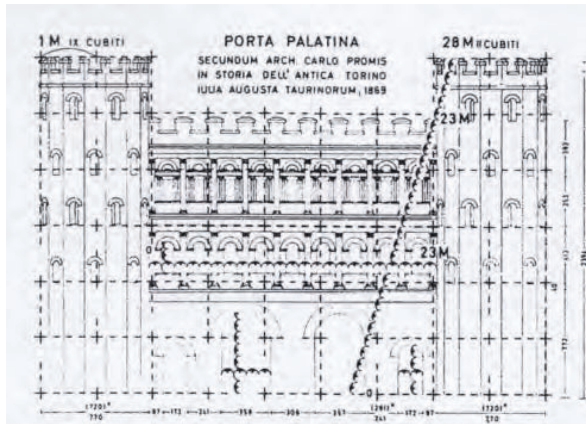


Fig. 4- graphic analysis by Kurent, excerpt (Kurent 1965).

In the graphical analysis developed by Kurent two different modules are highlighted, the *modulus structuralis* (2 cubits), and the *modulus compositionalis* (9 cubits). The *modulus compositionalis* would be, in Kurent's analysis, half the diameter of the circumference circumscribed to the polygon of 16 base sides of the towers and to 1/6 of their total height, including the philological reconstruction by Promis, while corresponding to a fifth of the width and height (reconstructed) of the *interturrio* (fig. 4). When studying such interpretative grid on the elevation derived from the present survey, we notice some inconsistencies. In fact, based on the measurements derived from the instrumental operation described above, the diameter of the surrounding circumferences at the base of the towers would be 25 roman feet (*pes*), that is 16.7 cubits (and not 18) and the overlay of the modular grid to the elevation, lined up on the impost plan of the major openings, would be moved by 1 cubit down (the first vertical module would be 8 cubits, not 9): this would also result in a fair correspondence of the openings' base on the towers with the module.

In an attempt to re-study the modularity in relation to the updating of survey's measurements, it would seem sensible to use a 13-feet composing module for tower-height partition, which corresponds exactly to the windows base (with a slight lag in the western tower equivalent to 1/2 foot for the firsts three

levels of windows) and to an approximate half of the base diameter (12.5 feet). The six times repeated module would not be sufficient to reach the top of the western tower (5 feet would be added), although the numerous restorations and reconstructions may have produced height variations (the half module would in fact amount to 6,5 feet). As for the *interturrio*, which corresponds to 68 feet (very close to the 45 cubits of the Kurent model), one could think of a subdivision into two horizontal modules (34 feet, half of which correspond exactly to the position of the central openings abutments) and a vertical partition with 21-feet modules (corresponding to the partition of the three levels of the facade), generating rectangular modules of 34x21 feet that approximate almost exactly the golden section (fig. 5).

Also for the representation of the details of the architectural order we point out a very accurate correspondence of the architectural elements to multiples of the basic module (1 *palmus*).

#### 4. Three-dimensional modelling

The last phase of the work that has been conducted has dealt with the geometric three-dimensional modelling of the city-gate on the basis of the previously conducted graphic analysis. The purpose of this work phase was to model the building with a precise representation of the constituent elements and the decoration in order to use this model both for the investigation on the historical transformations at the architectural scale and for the study and the representation of the different construction fabric configurations relating to these transformations.

For the subsequent stages of development of the work we intend to proceed with the analysis and comparison of the numerous archival drawings and documents related to the main phases of the transformations to the building and to update the three-dimensional model showing its quality and quantity (wherever possible) in order to prepare thematic and diachronic representations (static and dynamic) and readings

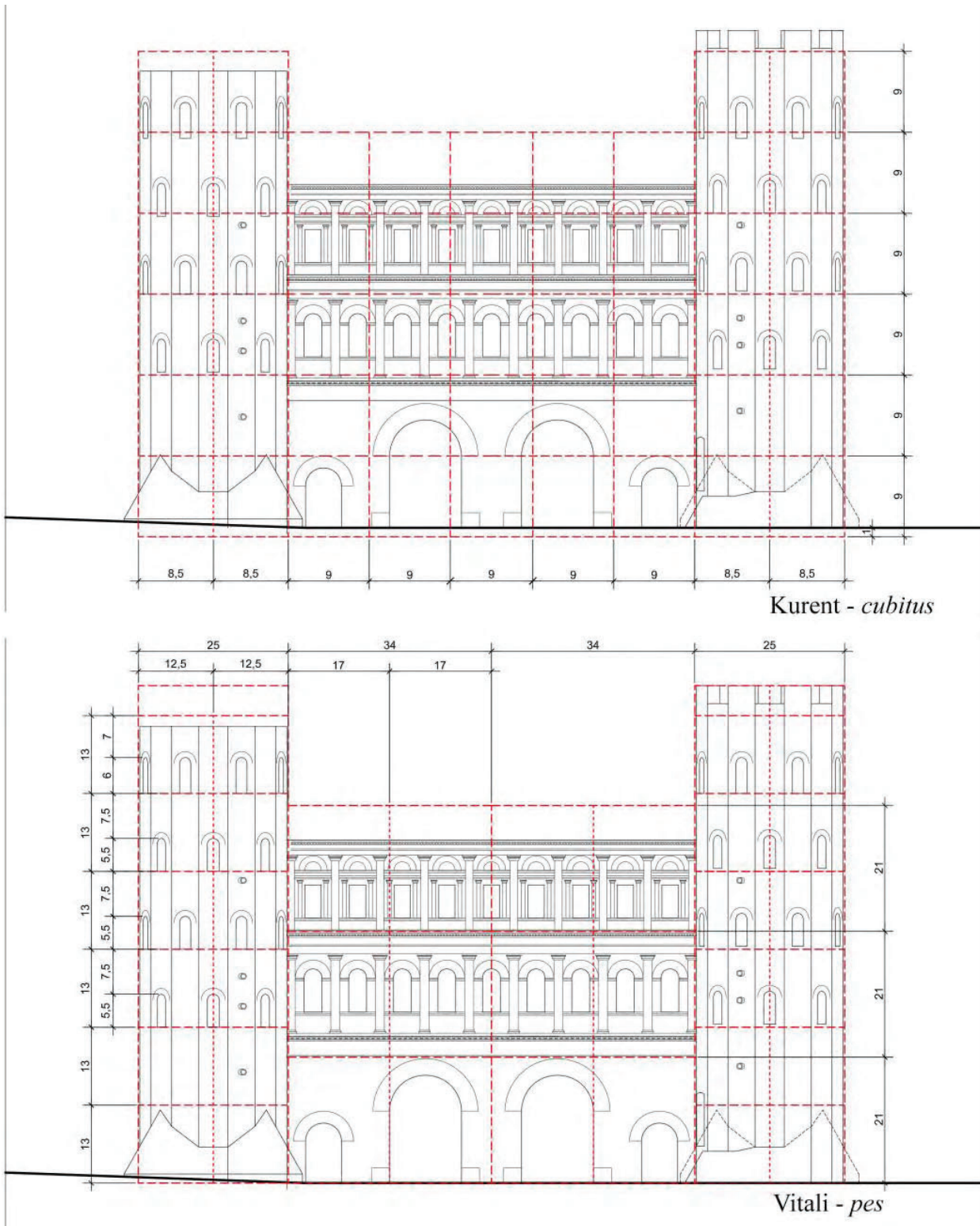


Fig. 5 – Graphical analysis, with a comparison – on the current survey – between the modular scheme set on cubits (Kurent) and the one set on feet (author).

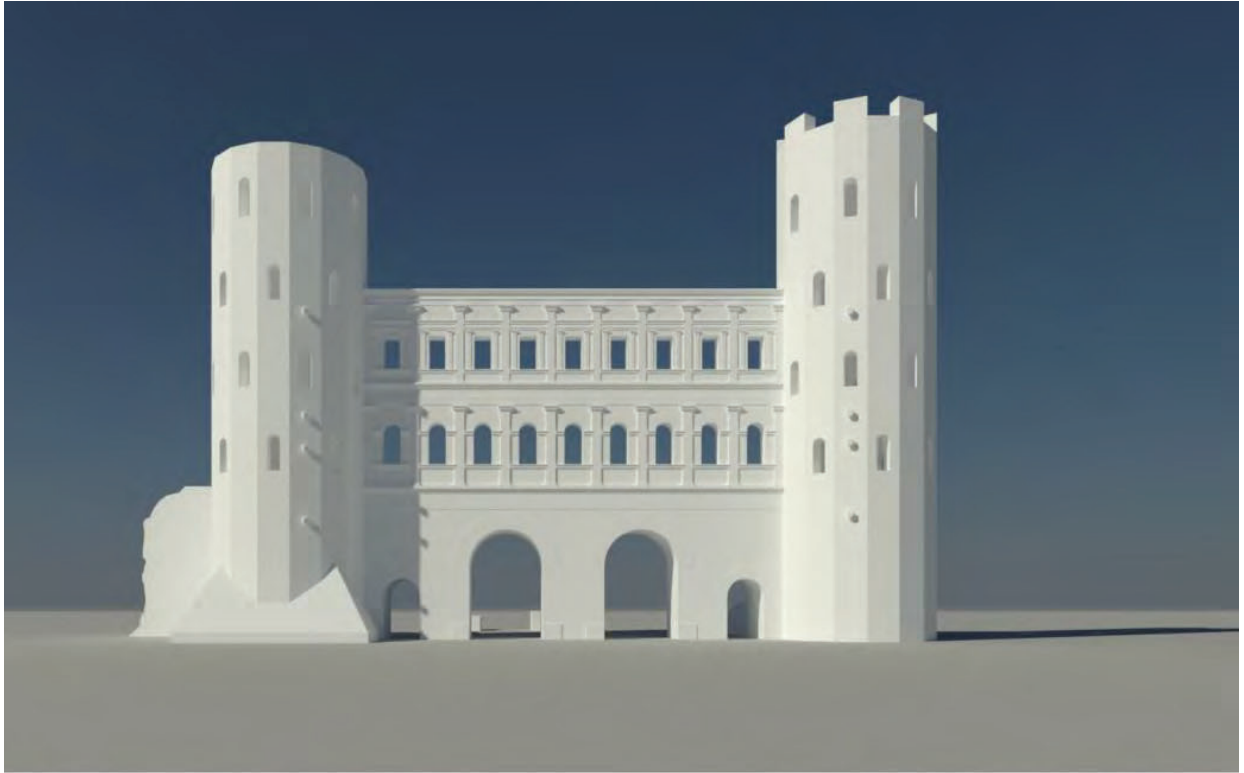


Fig. 6 – Render of the three-dimensional model of the *Porta Palatina*: overview and detail of the two-horizontal partition of the *interturrio*.

At the end of this research phase, it seems interesting to emphasize the fundamental role of graphic analysis and representation - both two-dimensional and three-dimensional - as a phase of a re-construction process that retraces the logic of composition and construction and verifies hypothesis, confirms intuitions, supports thought on historical bases. The work will be integrated

and completed in successive stages, and reviewed and/or re-evaluated in its methodological aspects, comparing the role and contribution of the multiple forms of representation, or even insisting on their dynamic significance in the reading of complex systems in favor of expressive forms more and more flexible and effective.

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