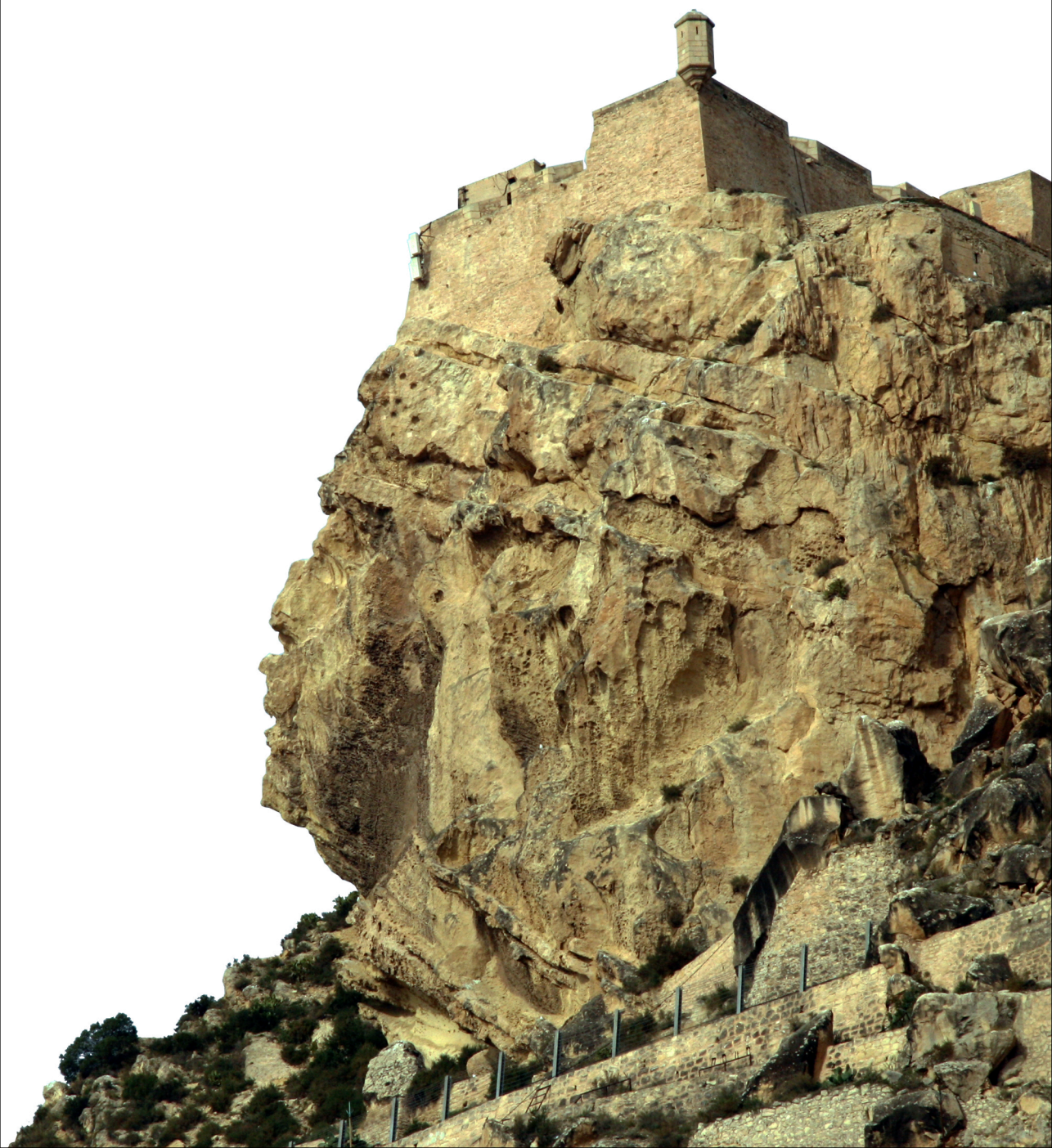


# 5 DEFENSIVE ARCHITECTURE OF THE MEDITERRANEAN

XV to XVIII Centuries

Víctor ECHARRI IRIBARREN (Ed.)



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## Form and Project of Modern Age Fortifications. The case of the city walls of Pisa

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### Abstract

The fortification “a la moderna” of Pisa in the Modern Age was not made, as in other Tuscan cities, with the construction of a new bastioned front, but strengthening the pre-existing medieval walls.

The construction of the new front was developed between the 16<sup>th</sup> and 17<sup>th</sup> century in two different phases. In the first phase, starting from the mid-16<sup>th</sup> century, a few of small bastions were built in some strategic points of the medieval circuit. Only in the first half of the 17<sup>th</sup> century, the defense system was completed by the military engineer Gabriello Ughi, with demilunes and outworks in earth.

The new defense system, demolished in the late 18<sup>th</sup> century, is described only in a series of historical maps and archival documents. This paper therefore aims at proposing the first results of a study on the 17<sup>th</sup> century fortification project, starting from a graphical analysis of the historical maps, in order to understand the design choices in the light of the progress of defense techniques at that time and of the constraints determined by the pre-existing structures and the orographic context.

**Keywords:** bastions, Pisa, Tuscany, medieval walls.

### 1. Introduction

The fortification “a la moderna” of the city of Pisa did not lead to the construction of a new bastioned front - as in other cases in Tuscany, such as Lucca, Livorno, Massa, Grosseto - but was realized by strengthening of the pre-existing medieval walls. Fortification works were carried out in two distinct phases.

In the first phase, starting from 1543, under the direction of the engineers Giovanni d'Alessio d'Antonio, known as Nanni Unghero (1490 ca.-1546), and Giovan Battista Bellucci, called “il Sanmarino” (1506-1554), only some points of the medieval walls were fortified with the construction of small bastions and provisional works in earth.

Only starting from 1626, a more organic phase began, with the construction of bastions in earth

following the project of Gabriello Ughi (1570-1638).

The bastioned front was later demolished in the late 18<sup>th</sup> century. Only three of the bastions built during the 16<sup>th</sup> century still remain today (fig. 1).

The bastioned front layout is therefore described exclusively in some archival documents and historical drawings. Among these, the following ones are particularly interesting for our research:

- a plan of the fortifications of Pisa, attributed to Giovan Battista Bellucci and dated 1546-1547 (National Library of Florence, ms., II, I 270, c. 7r);

- the plan of the fortifications of Pisa, drawn by Annibale Cecchi in 1646 (British Library of London, Additional Manuscripts, 48770, f. 16);



Fig. 1- Images of the only three existing bastions of the city walls of Pisa. On the left, the Parlascio Bastion; in the centre, the Barbagianni Bastion; on the right, the Stampace Bastion

- a plan of the fortifications of Pisa, dated to the 17<sup>th</sup> century (unknown author, Tongiorgi's Collection);

- "Pianta delle Piantate di gelsi da farsi sui baluardi nell'anno 1655" (State Archive of Florence, Scrittoio Regie Possessioni, A. 2. 86);

- "Pianta del campaccio degli ebrei", by Niccolao Stassi, 1769 (State Archive of Florence, Scrittoio Fortezze e Fabbriche, Fabbriche Lorenesi, f. 1958, ins. 257);

- The plan of the fortifications from S. Zeno to the Porta a Piagge, drawn by Giuseppe Santini in 1700 (State Archive of Florence, Mediceo del Principato, f. 2605, ins. 41);

- the drawing of the fortifications in a part of the city, drawn by Giuseppe Santini in 1701 (State Archive of Pisa, Fiumi e Fossi, Carte Topografiche, n. 12);

- The "Pianta delle fortificazioni e mura della città di Pisa con sue pertinenze dalla Porta Fiorentina sino alla Porta a Mare", 18<sup>th</sup> century (I.S.C.A.G., Fortificazioni);

Despite the several cartographic representations, the technical-military analysis of the Ughi's project has never been developed by the historians of military architecture. In this paper, therefore, we aim to show the first results of an ongoing research focused on the analysis of the seventeenth-century fortification project, based on the graphic analysis of the iconographic sources.

## 2. Constructions and transformations of the bastioned front in Pisa

The republican independence of Pisa definitively ended in 1509, when the city was firmly

conquered by the Florentines. The Medici's government began, therefore, a series of modernization actions that led to a deep change of the city, chosen as the second pole of Tuscany.

Under the government of Alessandro first, but mainly during the reign of Cosimo I and his sons Francesco and Ferdinando, the city lived a new period of recovery. Among the most important interventions, certainly the modernization of the urban fortifications played a key role.



Fig. 2- Detail of the retired flank with orillon in the Fortezza Nuova of Pisa

The first attention was paid to the Florentine "Fortezza Nuova" - built in the previous century by Filippo Brunelleschi and strongly damaged by the Pisans in 1496 - which was subjected to significant repairs and modernization works by Antonio and above all Giuliano da Sangallo between 1509 and 1512.

They built a quadrilateral stronghold on the southern corner of the fortress, characterized by angular bastions with retired flanks and orillons (fig. 2).

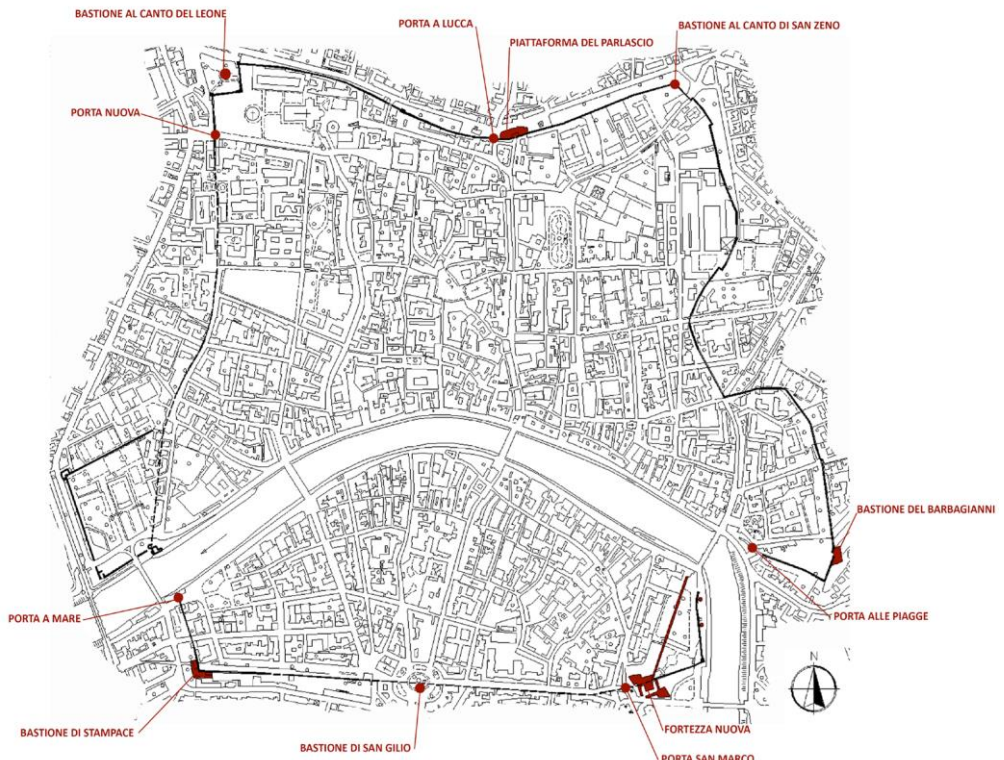


Fig. 3- Map of Pisa with highlighted the position of the bastions, the “Fortezza Nuova” and the active city doors in the 16<sup>th</sup> century

The new stronghold was the result of a formal experimentation begun by the Sangallo brothers in 1488 with the project for the fortress of Sarzana, and subsequently developed in the fortresses of Poggio Imperiale, Civita Castellana, San Sepolcro, Arezzo, Nettuno and Livorno.

Only in the middle of the 16<sup>th</sup> century, under the government of Cosimo I, the most important works of modernization of the urban defences started. Works were mainly aimed at reinforcing some strategic points of the medieval walls with some small bastions: the Parlascio Bastion, the Barbagianni Bastion and the Stampace Bastion, built with stone curtains by Nanni Unghero, and two bastions in earth, one in the “Canto del Leone”, the other in the “Canto di San Zeno”, designed by Giovan Battista Bellucci (fig. 3). These new structures were attached to the medieval walls, sometimes incorporating pre-

existing towers or strongholds. As, for example, in the case of the Parlascio Bastion, which included the remains of a medieval tower, which in turn was incorporated into the 15<sup>th</sup> century stronghold attributed to Filippo Brunelleschi, or the case of the Stampace bastion, which included the remains of a medieval tower, also strengthened in the 15<sup>th</sup> century. In both cases, the pre-existent towers were converted into cavaliers.

In some parts, the medieval walls were reinforced at the basis with scarp embankments, built reusing the earth extracted from the outer moat, then constipated and stabilized with grooves, as Maggi reports in his treatise (Maggi and Castriotto 1583, p. 30). In some parts of the defensive circuit, embankments in the moat, like faussebraies, were built for curbing the fall of the ruins of the walls if strongly mortared (Maggi and Castriotto 1583, p. 63).

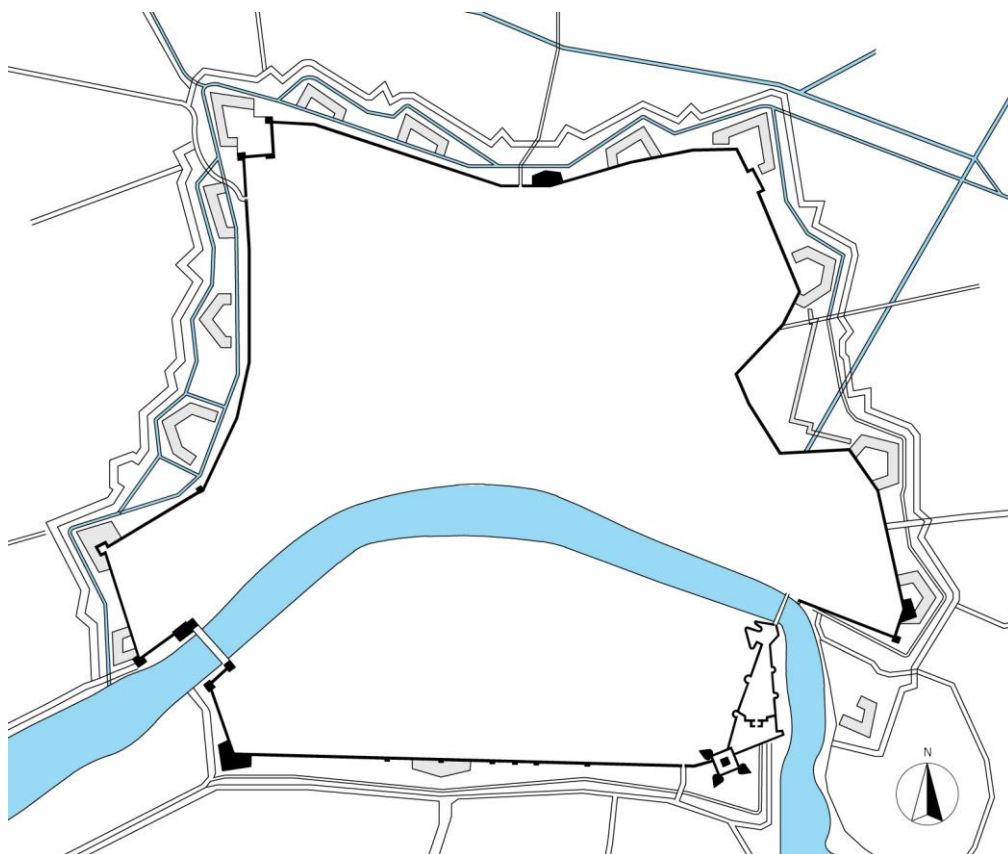


Fig. 4- Map of the seventeenth-century fortifications of Pisa (re-drawing of the Annibale Cecchi's plan, 1646)

In this first phase and throughout all the 16<sup>th</sup> century, the fortification program, however, did not have any organic character, being defined by localized and chronologically uncoordinated interventions, leaving still vulnerable some parts of the walls.

Only starting from 1626, a new bastioned front was conceived in its whole by Gabriello Ughi (fig. 4). New ramparts, built totally in earth, were placed in advanced position with respect of the medieval walls; in each rampart, the embankments were limited to the front and the flank, so they were more properly demi-lunes. This technique allowed the reduction of costs and time of construction. Several faussebraies were placed for defending the glacis and in the most vulnerable zones between the ramparts and the medieval walls. In 1630, the project was

reviewed by Giovanni de' Medici, military expert, who suggested to modify the dimensions of some ramparts and to make the glacis lower than the faussebraies; he suggested also to build some cavaliers in earth inside the walls and embankments at the basis of the medieval walls, up to half or at least one third of their height. These recommendations were not realized at least for the next twenty years, as evidenced by the report that in 1646 Annibale Cecchi, a military engineer, wrote about the state of the Pisan fortifications (British Library of London, Additional Manuscripts, 48769B, ff. 108-110). Works of completion and maintenance of the front are documented throughout the 17<sup>th</sup> century (see Bevilacqua and Salotti, 2011, pp. 181-219).

When Peter Leopold of Lorraine ascended the throne in 1765, a gradual and radical



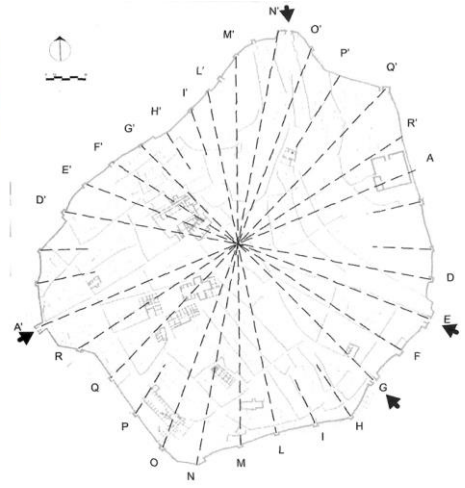
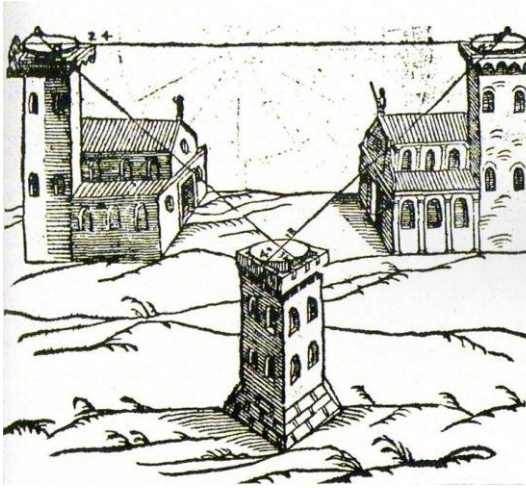


Fig. 5- Survey method proposed by Leon Battista Alberti (1452) and pisan medieval towers design in Iglesias, Sardinia (Cadinu 2001)

demilitarization of the Grand Duchy of Tuscany began. In 1767, the entire Grand Duchy's military organization was reformed, followed in later years by the alienation of artillery, ships, arsenals and fortifications.

Since 1781, for reasons of public health, the seventeenth-century bastioned front was totally demolished. The lands once occupied by demilunes were therefore rented to private citizens.

### 3. The Shapes of the historical city walls

The study of the design events that led to the realization of the modern "form" of the fortifications in Pisa, cannot be developed without an analysis of the historical survey and design methods. Methods that - in use since the 12<sup>th</sup> century and consolidated in modern design practice - have in fact led the design of the medieval walls of Pisa and their subsequent transformations. A line of defense in which the positioning of towers and accesses to the city were traced and controlled by a privileged point. This is the procedure proposed by Raffaello to the Pope Leo X to perform the surveys of individual buildings and already employed by Leon Battista Alberti in the survey of Rome in polar coordinates, continuing a late medieval tradition (fig.5).

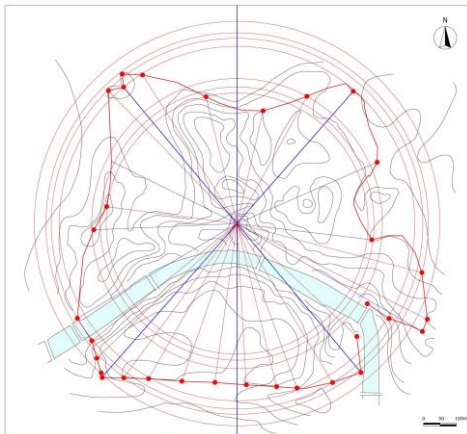


Fig. 6- Hypothesis of the layout of the medieval walls of Pisa. The layout appears to be controlled by a site positioned in order to allow a privileged observation of places to be measured and modified

This technique derives from the same procedure used for the construction of nautical maps, which have been in use for at least two and a half centuries, with the use of more than one polar coordinate centre, represented by physical elements (Guidoni 1983). Compass and benchmarks become the tools on which setting up the survey grid, first, and the city and its walls design, then. The analysis of historical cartography and the observation of the topography of sites show, in fact, a planning

process implanted on a central control point according to a practice found in several other Italian cities (Cadinu 2001, tav.35, p.123).

The modern defense line starts from the medieval layout, is expanded and equipped with bastions according to the indications of specialists, soldiers, military engineers. Cavaliers, platforms, bastions, demi-lunes and fortified citadels redefine - according to the experience of military technicians and the design guide of treatises - the shape of the city to resist the attack with firearms.

These modifications are represented in some historical maps stored in the archives and consisting mainly of survey (ichnographies and sections) performed by the various technicians between the 16<sup>th</sup> and 18<sup>th</sup> centuries. This condition highlights the importance of observing the drawings and identifying the geometric matrices used for the project. The constructions represented in the drawings - in the form of surveys designed for different purposes - can

certainly depart from the initial design as they were plotted on the ground and adapted from the original design, but nevertheless rich in graphic information.

Some elements are particularly interesting. When observing the medieval line and re-drawing it, a symmetrical global scheme, set up at a central point, is evident where the same position of the towers shows a North-South symmetry (fig. 6). The modern line is described in several documents already from the 16<sup>th</sup> century and, in its definitive layout, in some seventeenth-century representations, including the aforementioned one by Annibale Cecchi (1646) of great interest as it shows the pre-existing medieval line and the works designed and executed under the direction of Gabriello Ughi.

The analysis of the drawing highlights how the designer, for tracing the earth bastions profile, restarted from the three towers located in the northwest corner of the medieval city wall.



Fig. 7- Graphic construction of the north-west sector of the seventeenth-century front. There is a close link between the pre-existing structures - which guides the design setting - and the new "necessities" that are functional to the "modern" defense of the city

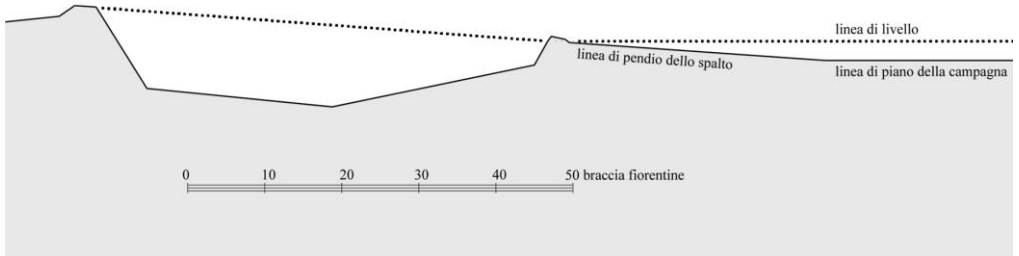
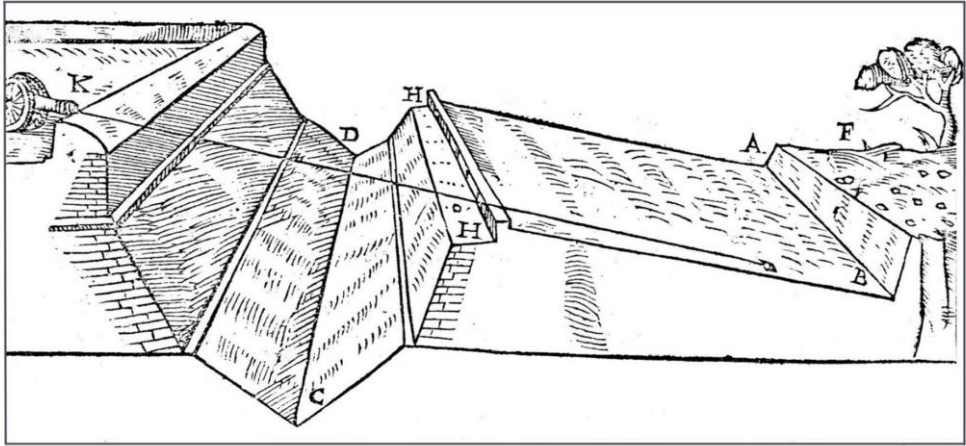


Fig. 8- Comparison between the works in Pisa (vertical section from the drawing by Giuseppe Santini in 1701, redrawn by the authors) and Maggi Castriotto (1583)

Defined the vertex of what will become the bastion of the “Canto del Leone”, the subsequent graphical steps and dimensioning (up to the definition of the profile of the covered way) appear coordinated from the Torre del Leone and the creation of the network of channels close to the medieval line (Fig. 7).

These works stand in support of the existing walls (at the time already equipped with some “modern solutions” realized in the course of the 16<sup>th</sup> century), excluding the west side - which mainly uses semi-bastions without retired flanks and separated from the inside by a channel network.

The entire perimeter of defense appears enriched and reinforced by numerous new ramparts of different shape and size, in order to conform to the tactical requirements and the existing circuit.

Other drawings from the 17<sup>th</sup> to the 18<sup>th</sup> century, integrated with vertical sections and reports, oriented following the cardinal axes, with metric scale, offer the possibility of a detailed analysis and a comparison with the military treatises.

Numerous analogies with what is prescribed in the specialist texts of the time can be seen in the drawings of the walls of Pisa, among them one in particular (fig.8).

This is the aforementioned drawing by Giuseppe Santini (1701), which in plan and section (profile) offers an interesting consistency with the diagrams proposed in the treatise of Maggi and Castriotto (1583).

It is noted in particular how the definition of the glacis profile is determined by the pull line and the ditch section has a “V” shape.

#### 4. Conclusions

The first results of the study highlight the complexity of the fortification project “a la moderna” of Pisa, mainly due to the irregularities of the medieval circuit and strongly influenced by the orographic and hydrogeological conditions of the site.

In the next future, the study will be extended to a larger part of the circuit, in order to highlight the geometric matrix of the project in its whole and to contextualize the project within the state of fortification techniques at the half of the 17<sup>th</sup> century.

#### References

- Alberti L. B. (ca. 1452). *Ex ludis rerum mathematicarum*. Ms. Galileiana 10, fols. 1r–16r. Florence, Biblioteca Nazionale Centrale.
- Bevilacqua M. G., Salotti C. (2011). *Le mura di Pisa. Fortificazioni, ammodernamenti e modificazioni dal XII al XIX secolo*. ETS Ed. Pisa. Italy.
- Bevilacqua M.G. (2007). “The Conception of Ramparts in the Sixteenth Century: Architecture, Mathematics and Urban Design”. In *Nexus Network Journal*, vol. 9, n. 2, Birkhauser Ed., Basel, Switzerland.
- Cadinu M. (2001). *Urbanistica medievale in Sardegna*. Bonsignori Ed. Roma. Italy.
- Cassi Ramelli A. (1996). *Dalle caverne ai rifugi blindati*. Mario Adda Ed. Milano. Italy.
- Docci M., Maestri D. (1984). *Il rilevamento architettonico. Storia, metodi e disegno*, Laterza Ed. Bari. Italy.
- Guidoni E., Marino A. (1983). *Storia dell'urbanistica. Il Cinquecento*. Laterza Ed. Bari. Italy.
- Maggi G., Castriotto I. (1583). *Della fortificatione delle città*. Camillo Borgominiero Ed. Venezia. Italy.
- Pirinu A. (2013). *Il disegno dei baluardi cinquecenteschi nell'opera dei fratelli Paleari Fratino. Le piazzeforti della Sardegna*. All'insegna del Giglio Ed. Firenze. Italy.
- Pirinu A. (2015). "I disegni di Rocco Capellino per le città di Oristano Sassari". In *XXXVII Convegno Internazionale dei Docenti della Rappresentazione/Dodicesimo Congresso UID*, Torino, 17-18-19/sett2015, Gangemi Ed. Roma. Italy. pp.271-278.
- Severini G. (1999). *Fortificazioni e controllo delle acque in Toscana fra '500 e '600. Il caso di Pisa*. ETS Ed. Pisa. Italy.
- Tolaini E. (1992). *Forma Pisarum*. Nistri-Lischi Ed. Pisa. Italy.
- Tolaini E. (2005). *Le mura del XII secolo ed altre fortificazioni nella storia urbana di Pisa*. Bandecchi e Vivaldi Ed. Pontedera. Italy.