# Ruins by the sea. Spanish towers in northern Puglia, between knowledge and risk of loss

Michele COPPOLA[1], Cristina TEDESCHI[2]
[1]*University of Florence*
[2]*Polytechnic University of Milan*
*e-mail: michele.coppola@unifi.it; cristina.tedeschi@polimi.it*

**Abstract.** The heritage of the 16th century towers built along the coast of the Kingdom of Naples against the Turkish attacks is today in heterogeneous conditions. Their best preservation is sometimes the result of a continuous use over time or strong restoration-reconstruction actions. Many towers, gradually abandoned since the end of 18th century, are in ruins, isolated in the country and excluded from visit trails, increasingly inaccessible. The position on the seafront makes their state of conservation very critical, with degenerative phenomena rapidly changing. A research conducted by the University of Florence and the POLIMI, is focusing on the study of the towers with a high risk of loss. The aim is to reach the best knowledge of construction, transformation and decay processes of these artefacts and an adequate level of risk awareness. This in order to identify the type, the urgency and the intensity of possible conservation works. Here we present the results of investigations carried out on a sample of the north coast of Puglia. After the complete documentation of the buildings, the work has been addressed to the recognition of the evolutionary phases and the building techniques. Typological and quantitative methods have been used to investigate the criteria of laying the stone masonry, outlining comparisons with techniques from the same period. Homogeneous groups of bricks have been analysed with mensio-chronological investigations. The study of stone material was made especially in relation to the action of the wind and the sea-salt aerosol. The concentration and penetration of salts has been evaluated according to the exposure of the surfaces in relation to the main air flows.
**Keywords:** Puglia, sea-salt aerosol, Spanish fortifications, building techniques, stratigraphic survey.[1]

## Introduction

Fortified architecture has been characterised for centuries by a natural predisposition to reuse and transformation to adapt itself to the evolution of techniques of siege and fire. In the contemporary age, the total loss of its original function has interrupted this "Darwinian" evolutionary process.

[1] English abstract is in D.Pittaluga, F.Fratini (eds.), *Conservation and promotion of architectural and landscape heritage of the Mediterranean coastal sites*, ed. F. Angeli, Milano, 2017, p.143.

The destiny of these artefacts is currently facing a crossroads: on the one hand there are buildings that are more accessible and more adaptable to conventional housing functions, which can potentially find a relocation in contemporary society; on the other hand abandoned and inaccessible structures, which are often situated out of the inhabited centres, isolated from the lines of communication, are likely to disappear. This category includes many viceroy towers, intended from the beginning to guard less accessible places, which are currently reduced in dramatic conditions. Due to the absence of maintenance programs and protection and safety measures, these buildings disintegrate under the incessant action of atmospheric agents. A project of the University of Florence and of the "*Politecnico*" of Milan, is carrying out a program of preliminary knowledge and diagnostics of these buildings. The goal is to create a solid knowledge which is intended to raise public awareness towards the risk of the loss of these monuments and address suitable conservation programs.

*Fig. 01 : The ruins of the Tower of Calarossa*

**1. The fortification of the coasts of the Viceroyalty of Naples**

The fortification initiatives of the coasts of the Viceroyalty of Naples responded to the growing menace of various forms of piracy generated in the context of North African regencies of the Ottoman Empire. The plan developed by Viceroy Pedro Alvarez de Toledo in 1532 foresaw the creation of a permanent defensive network of the coasts by repairing existing buildings and building new towers [RUSSO 2009]. Soon, deadlines and excessive coasts of implementation gradually slowed down the initiatives, which eventually, ceased for good. Only following new attacks did the defensive program be reactivated by Pedro Afàn de Ribera in 1563 [STARACE 2010]. The result was an integrated system, obtained by saturating the free spaces between the pre-existing ones with new towers, so as to guarantee a mutual visibility with new towers. The codified architectural scheme was declined according to the places, especially for the choice of building materials. A technician supervised the construction sites of the two adjacent towers, verifying the correct technical performance. In many cases the structures were not completed, thus often remaining without the upper crown. In other cases, they were completed in every part and quickly activated. To determine this variability was the distinction between two bases functions: sighting and armed defence. Unreachable towers overlooking the sea, little exposed to direct attacks, had to guarantee above all the transfer of the alarm signal along jagged cliffs and, therefore, they didn't require plumbing defence apparatuses. Towers placed on sandy coasts, easy landings for penetration into the hinterland, had to ensure the first intervention in order to contrast attacks from the sea [CISTERNINO 1977]. Only around the first half of the eighteenth century the network of towers became fully operational, thus playing an active role of control of the coasts. The gradual decrease in maritime threats from the sea culminated in 1785 with the treaty of peace between Spain and the Regency of Tripoli [DE SARIIS 1794]. The need for a constant coastal garrison failed and the function of the towers gradually declined. Some of them were used with similar functions (customs or telegraph), undergoing transformation works (insertion of openings, addition of external masonry stairs).

## 2. Case studies

The survey presented here concerned the stretch of coast between the mouth of the Fortore and Vieste Rivers, the natural Northern border of Apulia. As case studies, four towers were selected, with particularly critical conditions: *Torre Mozza*, *Torre Scampamorte*, *Torre Calarossa* and *Torre di Sfinale*. *Torre Mozza* was built near the ancient port of Civita a Mare, on the Northern arm of the mouth of the Fortore river that was bifurcated in the Middle Ages. The particularity of this tower, from which the toponym of "*Torre Mozza*" derives, is that it was left unfinished. Already in 1594 Carlo Gambacorta described it and designed it as unfinished [STARACE 2010]. The reason for this interruption of works could be linked to the torrential regime of the Fortore river. A flood event during the period of construction of the tower may have caused the silting of this branch of the river, the definitive decline of the port of Civita a Mare and the swamping of the area. The presence of a keeper documented from 1583 at least until 1676 suggests that the function of this tower has been nevertheless guaranteed [CISTERNINO 1977]. The inaccessible state of the ruin in which it is found today has been documented since the end of the 19th century. Portions of walls built over time are preserved to integrate and use the upper floor. *Torre Scampamorte* was built in 1568 at the centre of the 25 km long isthmus that separates the lagoon of Lesina from the sea, near Saint Andrea canal, which at that time was the main mouth of the lake. Its construction completed the garrison of the coasts of the lake, until then entrusted to two towers placed at the extremities of the isthmus: *Torre Fortore* (on the port of the southern arm of the river) and *Torre Mileto* (rebuilt from the Spanish program) [TROCCOLI 1975]. In 1569 it was already finished and accessible [PASANISI 1926]. The documented presence of keepers proves its continuity of use during the seventeenth century, even after the earthquakes and tsunamis of 1627 [POARDI 1627] and 1646. However, a report drafted in 1685, recommended the total reconstruction of the tower in a new position away from the channel [STARACE 2010]. It's not currently possible to establish whether this actually happened, but we can state that the building has numerous signs of repair. The sanding of the St. Andrea canal in 1882 led to its abandonment [ROSANO *et al.*1903]. Today the tower is an isolated ruin in the Mediterranean scrub; it can be reached by sea or by following a road through the sandy dunes for about 10 km. The existence of *Torre Calarossa* was already attested in 1569 [FAGLIA 1977]. Its location had to guarantee the transmission of the optical signal circumventing the rocky outcrop of Mount d'Elio that separates the two lagoons. According to Gambacorta the tower connected *Tower of Mileto* directly to the Tower of Monte Pucci, passing the medieval towers of Varano and Rodi [STARACE 2010]. The tower seems to have been garrisoned until the nineteenth century. For at least 50 years it has been a ruin of which only the north and west walls remain, surrounded by huge collapsed portions. Among its peculiarities, the presence of an upstream wall structure perhaps due to an element of access on the upper floor, probably integrated by retractable devices, should be noted. The Tower of Sfinale is inserted in a tight sequence of viceroyal towers that had the function of protecting the rocky and jagged coasts between Peschici and Vieste. Even its construction dates back to the late 60's. The first keeper dates back to 1573 [CISTERNINO 1977]. As for Calarossa, the guarding and alarm function is flanked by the armed guard of the adjacent bay. The building, used until the nineteenth century, today presents itself as a ruin.

### 3. The Survey

The first phase of the study was the survey of the actual situation carried out with integrated 3D scanning and photogrammetry systems. The adequate restitution of the significant works (plants, sections, elevations), allowed to evaluate the morphological characters of the masonry structures and the macroscopic degenerative phenomena (deformations, injuries, collapses). Surveys were carried out on the technological characteristics of the individual phases of construction and transformation. A survey was carried out on materials, based on the macroscopic analysis of the portions installed and on the study of detached micro-fragments found near the wall structures.

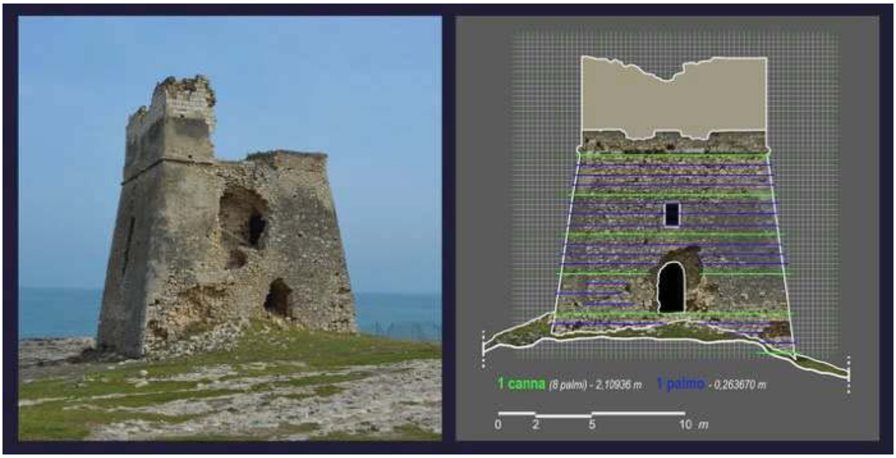



*Fig. 02 : Sfinale Tower. Masonry horizontal alignments of the South side*

### 3.1. Architectural characters. Fragments of construction history

Through the methods of archaeology of architecture, a survey was started on buildings to identify construction and transformation phases and to understand their articulation. In addition to the usual identification of the stratigraphic units and mutual relations, a typological analysis was carried out on masonry units, to identify suitable criteria among constructive actions. In general, the four towers have similar sizes, with one side at the base 12-14 metres long. The first obvious data is the diversification of the inclination of the sloped wall in the different realisations, due to different ways of design and transposition of the project. Each floor is occupied by a single room, basically with a square pan scheme, barrel vaulted. The openings seem to be always modified. The room on the lower floor had no openings and usually housed only the access passage to the underground cistern and the stairwell connecting to the first floor, usually inserted in the thickness of the upstream wall face. The access gateways that are visible today are almost always the result of more or less accurate subsequent interventions. Except for rare cases of small openings, usually facing the sea, all windows are the result of the enlargement of loopholes. On the upper floor there is a fireplace, almost always in a central position on a wall. On the adjacent walls there are niches, the access to the collecting chamber from the cistern, the access to the second stairwell, inserted into the wall upstream, to reach the roof terrace. Here the chimney ends and you circulate behind a more or less high parapet. In the standard model, the parapet had to be replaced by cantilevered battlements on machicolations. The absence of evident traces of collapses and repairs suggests that these plumbing defence devices have never been realised in the towers surveyed. The building material is limestone, collected on the surface or obtained from rock formations often at the base or in the surrounding areas. The walls are made up of two vestments made with rough-hewn stones layed in rows or rustic stones, assembled with abundant lime mortar beds and regularized by a wide use of wedges. The thickness of about 3 meters is reached through a mixture of lime mortar conglomerate, stone fragments and pebbles.

*Fig. 03 : Torre Scampamorte. Loss of stone elements from the southern wall*

The external corners are made up of squared and finished parallelepiped blocks, extracted from different rock formations with regard to the collecting stones of the main building's masonry. In many cases these are tender calcarenites, as evidenced by the traces of old stones buildings (gradines) spread on the flat faces of the blocks at Scampamorte or Calarossa (fig.03, fig.01). A significant aspect of the masonry technique used is the use of the so-called "*cantieri*" system of the Campania area [D'APRILE 2003], based on the assembly of the masonry by scanning in periodic horizontal applications of defined heights. In the Sfinale tower the step of this scan corresponds to two palms (1 palm = 26.367 cm). At Sfinale (fig.02) even the squared angular segments, of constant height equal to about 1 palm, are included in this scan in the number of two for each "*cantiere*". A similar constructive attitude is also found in *Torre Calarossa* and *Torre Scampamorte*. In the latter case, the study of horizontal rows or lines has allowed the identification of diversified construction criteria on the four sides of the tower, unified by common horizontal elements starting from the second floor [COPPOLA 2016]. The use of bricks is limited to repair actions. At *Torre Scampamorte* the bricks were used intact or in fragments, to integrate the gaps in the shafts for the flues and in the wall surface. In these and other masonry integrations the "*cantieri*" technique is not present. Through comparisons with known local productions, it would seem possible to place this brick production between the seventeenth and eighteenth centuries. There does not seem to be any substantial difference between the masonry work of the vertical vestments and that of the barrel vaults, in which a greater use of elements in the form of rough slabs prevails. With the exception of substantial repairs carried out at Scampamorte, the other three towers do not present considerable additions as much as subtractions and mutilations. In the upper parts there may be traces of attempts of a cant after the loss of defensive function.

*Fig. 04 : Weathering of lime mortars by the marine aerosol*

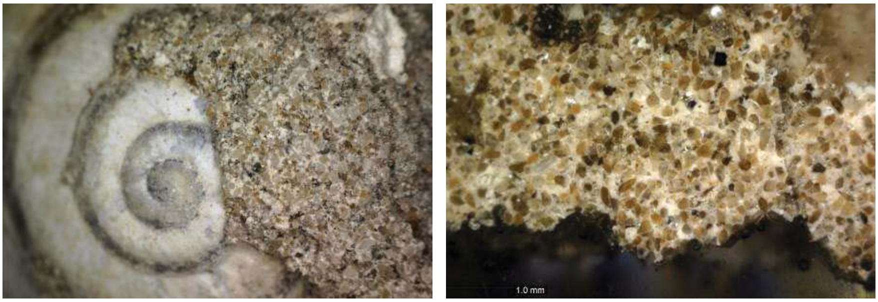
**3.2. Degenerative processes of stones materials.**

The abandonment conditions outline a very precise picture of degenerative processes. However, if substantial previous actions such as breccias, partial demolitions or collapses are excluded (such as those of Calarossa), the remains set up do not present problems of general instability, but rather the disintegration of the masonry work itself due to problems of rainwater infiltration and above all of mortars' erosion. The macroscopic recognition of degenerative phenomena shows a strong erosion due to the action of marine aerosol. Signs of "rosette" degradation of mortars and plasters, but also macro-alveolizations of limestone. It was considered to carry out an investigation campaign on micro-samples of degraded material detached from the support, to evaluate the physical-chemical conditions and attempt to focus some aspects of this erosive process. Interesting data emerged with regard to the nature of the materials themselves.

The SEM survey on a detached angular-block fragment confirms the organogenic nature of these calcarenites, with evident fossil inclusions. Also, the study of degraded fragments of mortars found at the foot of the walls allowed to draw a preliminary picture on the composition and packaging of these materials.

The constant presence of aerial lime binder is confirmed, both for mortars relating to original phases and for mixtures applied following repair and integration. In the latter case, at Scampaporte tower in some cases (from EDS probe) a significant presence of iron in the binder was recorded, which should be clarified better with further insights but that would seem to exclude the use of iron filings in the mixture. An unavoidable aspect of these buildings is their position a few metres from the sea that exposes them to the action of atmospheric agents, especially in the wind. In this part of the Adriatic Sea the winds characterised by the greatest frequency of appearance are those coming from NNO - ONO [APULIA REGION 2009] and are also those that reach the highest speeds. Considering that the entire coast line investigated is facing north, we can understand that these buildings are particularly prone to these winds throughout the year. Therefore, with this assumption it has been decided to address a large part of the study of the fragments to the evaluation of the diffusion of chlorides from marine aerosols in the porosity of stone and mortar. Sodium chloride is detected in all micro-samples at various depth levels, depending on the porosity of the stone material. It should be noted in this regard that in many fragments of detached mortars there was a presence of chlorides throughout the thickness. This seems to be due to the use of aggregate sea sand.

Another interesting aspect concerns the porosity of these materials. Attempts were made to understand how the action of the marine aerosol is decisive in the alteration of the porosity of these materials and at what depth it may be possible to find this phenomenon.



*Figg. 05,06 : Fragment of degraded mortar observed under an optical microscope*

*Tab. 01 : Chemical analysis of binder, aggregate and the chloride concentration*

| Mortar sample n. | Insoluble Residue (%) | Soluble Silica (g) | $Cl^-$ (%) |
|---|---|---|---|
| **1** | 25,73 | 0,37 | 0,3125 |
| **5** | 51,46 | 0,23 | 0,6173 |
| **6** | 57,22 | 0,35 | 0,6315 |

The analyses carried out through *the Mercury Porosimeter* (*AutoPore IV* from Micromeritics), show how the porosimetric distribution of the stones and the external mortars exposed to marine aerosol, is completely different from that found in materials laid inside of the tower. It is also interesting to observe how the stones laid internally, but close to some openings, have a distribution of pores that highlight the presence of strong sea aerosol currents, which increase the degradation also in the internal part of the structure.

## 4. Conclusions

This investigation on four pilot towers aimed at verifying the potential for further investigations. The survey on architectural characteristics and on the dynamics that led to the current configuration of the manufactured articles has a central role to understand the state of conservation and the levels of risk. Very interesting aspects related to the technical culture emerged that declined the implementation of the project. Aspects of transformation events and degenerative issues have emerged. The determining role of wind and sea aerosol occurred in the erosion process of stone materials, which deserves to be studied more systematically and kept under control. The prerequisites for a broader investigation program have been created that can lead to a level of knowledge and diagnosis that will provide concrete proposals for actions to protect, conserve and enhance this system of buildings.

## Bibliography

APULIA REGION (2009) - *Piano regionale delle Coste. Rapporto ambientale. Allegato n. 2. Il clima meteomarino sul litorale pugliese*, Bari, 2009.

BELTRANO O. (1644) - *Breve descrittione del Regno di Napoli. Diviso in dodeci provincie*, Napoli.

CISTERNINO R. (1977) - *Torri costiere e torrieri del regno di Napoli (1521-1806), Castella 15*, Istituto Italiano dei Castelli, Roma.

COPPOLA M. (2016) - *Torre Scampamorte on lake Lesina. Half-light zones in the maritime defenses of the Kingdom of Naples* in Verdiani G. (ed.), *"Defensive Architecture of the Mediterranean. XV to XVIII centuries". vol. III*, Didapress, Florence, pp. 419-426.

D'APRILE M. (2003) - *Murature campane in calcare di età aragonese,* in Fiengo G., Guerriero L., (ed.) *"Atlante delle tecniche costruttive tradizionali"*, Arte Tipografica Editrice, Napoli, pp. 261-274.

DE SARIIS A. (1794) - *Codice delle leggi del Regno di Napoli. Libro II*, Ed. Orsini, Napoli, pp. 254-261.

DOEHNE E. (2002) - *Salt weathering. A selecting review,* in Siegesmund S., Weiss T., Vollbrecht A., *Natural Stone, Weathering Phenomena, Conservation Strategies & Case Studies*, Geol. Soc., London, pp. 51-64.

FAGLIA V. (1977) - *Visita alle torri costiere di Capitanata (1594-1976), Castella 15,* Istituto Italiano dei Castelli, Roma.

LUBELLI B., VAN HEES R. P. J., GROOT C. J. (2004) - *The role of sea salts in the occurrence of different damage mechanisms & decay patterns on brick Masonry*, in *"Construction and Building Materials"*, v. 18. pp. 119-124.

MAURO A. (1998) - *Le fortificazioni nel regno di Napoli*, Giannini, Napoli.

PACICHELLI G. B. (1703) - *Il Regno di Napoli in prospettiva diviso in dodici provincie. Parte terza*, Napoli.

PASANISI O. (1926) - *La costruzione generale delle torri marittime ordinata dalla R. Corte di Napoli nel sec. XVI*, in "*Studi di Storia Napoletana in onore di Michelangelo Schipa*", Ed. ITEA, Napoli, pp. 423-442.

POARDI G. (1627) - *Nuova relatione del grande e spaventoso terremoto successo nel Regno di Napoli, nella provincia di Puglia, in venerdì alli 30 di luglio 1627*, Ed. Grignani, Roma.

REGIO OFFICIO TOPOGRAFICO DI NAPOLI (1830) - *Carta rilievi delle Coste dell'Adriatico dal fiume Tronto a Gagliano del Capo di S. Maria di Leuca, foglio 13,* (from the original documents stored at the historical archives of IGMI, aut. n. 6949, of 20/06/2017), www.igmi.org.

ROSANO P., ZACCAGNINO D., MAJOLO D. (1903) - *La laguna di Lesina e le sue quistioni. Volume I*, parte speciale, Ed. Giannini, Napoli.

RUSSO F. (2009) - *Le torri costiere del Regno di Napoli: la frontiera marittima e le incursioni corsare tra 16° ed il 19° secolo*, Ed. ESA. Napoli.

STARACE R. (2010) - *Torri costiere della Capitanata. L'ispezione del Marchese di Celenza*, Ed. Sudest, Manfredonia.

THEOULAKIS P., MOROPOULOU A. (1999) - *Salt crystal growth as weather mechanism of porous stone on historic masonry* in "*Journal of Porous Materials", vol. 6*. Springer Publishing. NY, pp. 345-358.

TROCCOLI M. (1975) - *Le torri di Puglia. Le torri costiere*, in De Vita, R. (ed.) "*Castelli, torri ed opere fortificate di Puglia*", Ed. Adda, Bari.