

# THE TORRE DEL MARZOCCO AND THE WIDENING OF THE ENTRY CHANNEL TO THE INDUSTRIAL PORT OF LIVORNO

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**Abstract** – The Torre is an ancient watchtower, dating back to the 15<sup>th</sup> century, and is subject to Italian laws for the protection of the historical and cultural heritage. Located in the heart of the port of Livorno to the north of the city, the Torre del Marzocco symbolizes the past, the present and the future of the city, rooted in port activities and its traffic. The present contribution presents a project of the North Tyrrhenian Sea Port Network Authority aimed to redevelop and renovate the ancient marine landscape of the Marzocco Tower, through the creation of a water basin around its basement. At the same time this project aims to widen the entry channel to the port of Livorno, as a safety measure towards the secure access of the great ships of new generation to the industrial area of Livorno’s port.

## Introduction - The Marzocco Tower

Since 1439 there had been increasing interest from the Florentine Republic in the refortification of the Port of Pisa, the shallow basin of water immediately north of the small settlement of Livorno, near the mouth of the Scolmatore river.

Evidence of Florentine interest was the construction of the majestic Torre Nuova also known as the Marzocco.

The outside wall, which rested on the seabed, was built in 1465. By May 1466 the construction of the Tower’s foundation, at sea level, had been authorised.

The building of the magnificent Tower continued at a snail’s pace for a total of 20 years until 1478/79, stretching across the Medici periods of Cosimo il Vecchio, Piero il Gottoso and Lorenzo il Magnifico.

The tower has a polygonal floor plan, reminiscent of the pre-existing towers of Porto Pisano, in particular the 12<sup>th</sup> century *e Magnturres dali*.

However, historians claim that the polygonal section and structure of the tower are of a more classical influence, citing the Athenian Tower of the Winds. Detailed historical reconstructions can be found in the publication “*L’Antico Porto Pisano e la Torre del Marzocco a Livorno*” by Giampaolo Trotta [8], commissioned by the Port Authority and edited in cooperation with the Italian *Soprintendenza* (Ministry for heritage and cultural activities), the public body established for the safeguard of historical and cultural heritage.



Figure 1 – View of Livorno and Porto Pisano in a 17<sup>th</sup> century copy of a 1540 drawing: detail with the towers of Porto Pisano (da *Livorno e il Mediterraneo*, 1996, p. 91)



**TORRE DEL MARZOCCO**  
1466- 1479 LIVORNO



**TORRE DEI VENTI**  
50 a.C. Atene

Figure 2 – Comparison between the Marzocco Tower and the Torre dei Venti (Athens, 50 b.C.).

The tower is about 50 m high, has an octagonal floorplan and a scarp base on which the tower drums were built. The section measures about 12m and atop the tower is an octagonal spire below which is a balcony with corbels. It is clad with smooth slabs of white marble from the Monti Pisani and the name of the corresponding wind is inscribed on each of the eight corners (Mezzodi, Iscilocho, Levante, Grecho, Tramontana, Maestro, Ponente, Gherbino).

The walls are thick, have small rectangular windows, and the rooms have octagonal ogival vaults. Originally the balcony at the top of the tower was covered by the roof which bore a sphere surmounted by a gilded statue of the *leo martius*; the lion of Mars and symbol of Florence. It was from this statue that the name “Torre del Marzocco” came.



Figure 3 – Marzocco Tower “Torre Nuova” - Pennant on the Arnolfo Tower of Palazzo Vecchio, Piazza Signoria, Firenze

The historical research outlined above has evidenced that the native landscape of the Marzocco Tower was a marine setting.

Currently, the Marzocco Tower is landlocked at the southern extremity of the west bank of the Toscana Docks at the entry channel to Livorno’s industrial port, as shown in the photo. The landscape of this important historical heritage is now the docks at the heart of the industrial port of Livorno.



Figure 4 – The tower’s present landscape.

## **The Project and technical insights**

The featured project concerns the works necessary for the banking of the west side of a channel which at present is the only way to access the commercial and industrial port of Livorno, as well as the creation of a new water basin around the Marzocco Tower.

Currently, the channel leading to the port is about 97 m wide with a draft of up to 14 m at the center, while alongside the banks it is just a few meters deep. The increasing size of container ships that will be using the commercial port has led to the need to widen the channel to 120 m, if trading volumes are to rise. It is also necessary to dredge the full width of the channel bed to a depth of 13.5 meters.

In order to achieve this important objective, the Port Authority requested the construction of an embankment on the Marzocco Tower side of the access channel that would make it possible to obtain a depth of 13.5 m for ship drafts.

The project provides for a breach in the embankment wall, to allow a flow of interchange between the harbour and the water basin around of the Tower.

Plans for the banking of the Marzocco area and subsequent dredging of the canal have been hindered by oil pipelines, mid-tension electricity cables and other utilities which run across the canal at a maximum depth of -15.50 m.

Indeed, in order to remove these interferences, it was necessary to excavate a new concrete tunnel under the seabed and relocate the pipelines and other utilities inside it. The tunnel, realized with a Tunnel boring machine (TBM), is a very important geotechnical achievement for its depth of -20 meters under sea level. The latter has just been completed and is essential to the future operations of the port, as outlined above, for it will allow for the widening and dredging of the channel.



Figure 5 – Widening of the entry channel to the industrial port of Livorno.

Due to the importance of these works and the proximity of the Marzocco Tower several specialistic analyses have been performed to investigate the technical aspects.

The following aspects were analyzed specifically for this project: the archeological risk, the Marzocco Tower's foundation, the subsurface, and the water basin's flow.

The archeological risk has been investigated through historical research carried out by Archeodata Cooperative Society [3]. The archeological report has been drawn up, and continuous archeological monitoring will take place during the works.

Geological diagnostic investigation was required to ascertain the geotechnical characteristics of the terrain and the type of foundation of the 15<sup>th</sup> century tower. This information was essential for the proper forecast of the impact of different construction alternatives influencing the historic tower as a result of the broadening of the industrial channel.

To investigate this aspect the Port Authority commissioned geological studies in 2008 and in 2014 on the area of the Tower. They included vertical and inclined sampling of the Tower base and geophysical investigation [4].

The geophysical survey was performed with Electrical Resistivity Tomography (ERT) and 3D Ground Penetrating Radar (GPR) by the Department of Earth Sciences of the University of Pisa and the Geostudi Astier [6].

The geophysical and geologic data have been correlated to identify the size and typology of the foundations, and to pinpoint the possible presence of buried archeological structures. Together with the survey of the Tower's foundations, adjacent areas and those within the perimeter walls were also investigated to identify additional archaeological structures in the subsoil, with regard to position, shape and extension.

The subsurface has been analysed through coring, dilatometric tests (DMT), cone penetrometric test (CPTU) and downhole [7]. Investigations were also carried out from a stratigraphic and micropaleontologic point of view, to obtain a biostratigraphic and paleo-environmental characterization of the deposits.

The micropaleontologic analysis was based mainly on the species of calcareous nannofossils, ostracodes and foraminifera that were discovered in the samples examined [2].

Lastly, carbon fourteen dating has been performed on wooden elements of anthropic origins, discovered in the area of the Tower's foundations [5].

The micropaleontological study was conducted by personnel of CNR (National Research Council of Italy), a public body and largest research center in Italy.

Last of all, the Society AM3 Spin Off of the University of Florence [1] carried out a hydrodynamic and numerical model study to investigate the flow within the water basin that will be dug around the Tower. On-site measurements and analyses will be carried out in the course of the works to verify the oxygenation levels and flow of the waters, to avoid the occurrence of eutrophication.

## Results

Studies conducted through historical, archeological, and other documentary material point to a very low level of archeological risk for the oldest periods examined – Etruscan and Roman periods. Such a risk is most certainly increased with regards to the structures of the Porto Pisano, built starting from the 12<sup>th</sup> century. The studies showed the native marine landscape of the Marzocco Tower (Torre Nuova).

Thanks to this geological and geophysical survey it has been possible to establish the type and extent of the Marzocco Tower's foundations, something of primary importance to ensure the stability of the tower and minimize interferences to the ground during work to reprofile the banks of the channel.

The geological and geophysical survey showed in fact that the original engineers replaced and improved the soil beneath the tower, as far down as the layers with better geotechnical characteristics, over an area far greater than the base of the tower proper, as well as creating a subsurface basement with gravel and cemented gravel and further down with lime and stone chippings to reach a depth of -6.5 m under sea level.

In the fortification area the subsurface reaches a depth of about -6 m, with layers of gravel, stone chippings, clay-brick fragments for the first 4 meters and a layer of stone chippings and slacked lime at the deepest level, as shown in the vertical and horizontal sections of tomography. Before this survey it was believed that the Marzocco tower was founded on rock outcrops.

The Ground Penetrating Radar (GPR) 3D survey of the foundations of the Tower has evidenced the possible presence of early constructions, together with materials from their collapse. However, there is no correlation between these finds and the known building phases of the tower, with the exception of those dating to the first half of the 16<sup>th</sup> century. Therefore, there is a possibility of unknown or chronologically dubious structural elements in the architectural history of the Tower.

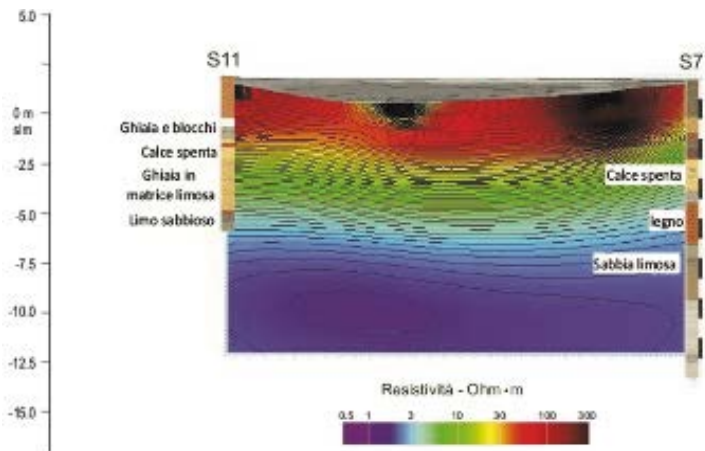


Figure 6 – Electrical resistivity Tomography - Vertical section.

Tavola 38

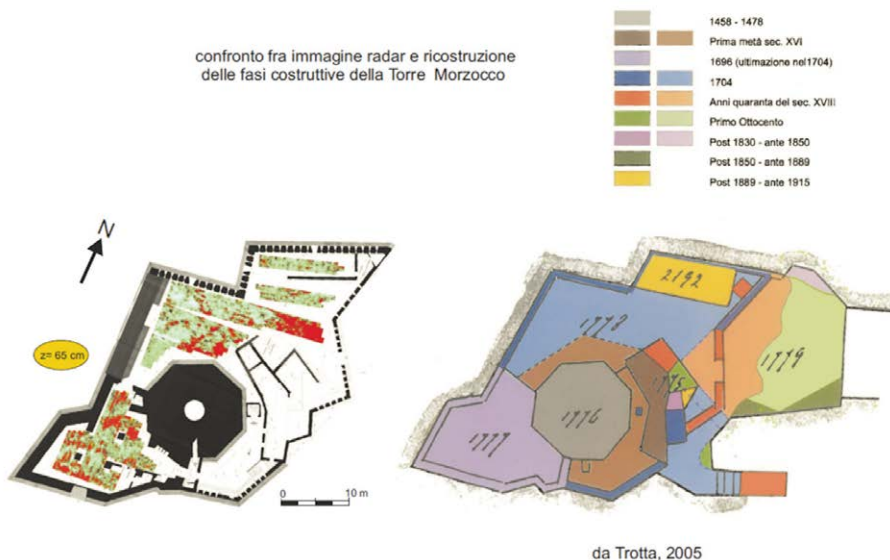


Figure 7 – Comparison between Ground Penetrating Radar (GPR) 3D and the archaeological studies on the construction phases.

The stratigraphic study, mainly based on results from micropaleontological analyses and radiometric dating, has led to the identification of four prevalent stratigraphic units of different periods and paleo environments, with a recent surface layer (Holocene) and two pre-existing ages, Pleistocene Sanerniano e Pleistocene Tirreniano.

Results of the hydrodynamic study show that during the construction of the water basin around the tower it will be necessary to plan for a pumping station to track the oxygenation levels and flow of the waters until completion of the water basin.

The Marzocco tower's water basin project was submitted to the office of the "Soprintendenza for architectural and landscape assets, for historical, artistic and demo-ethno-anthropological heritage for the provinces of Pisa and Livorno", which approved the plan in 2014. It was included in the port regulatory plan with the objective of creating a new pier around the Torre del Marzocco. The shape of the water basin is shown in the picture below.

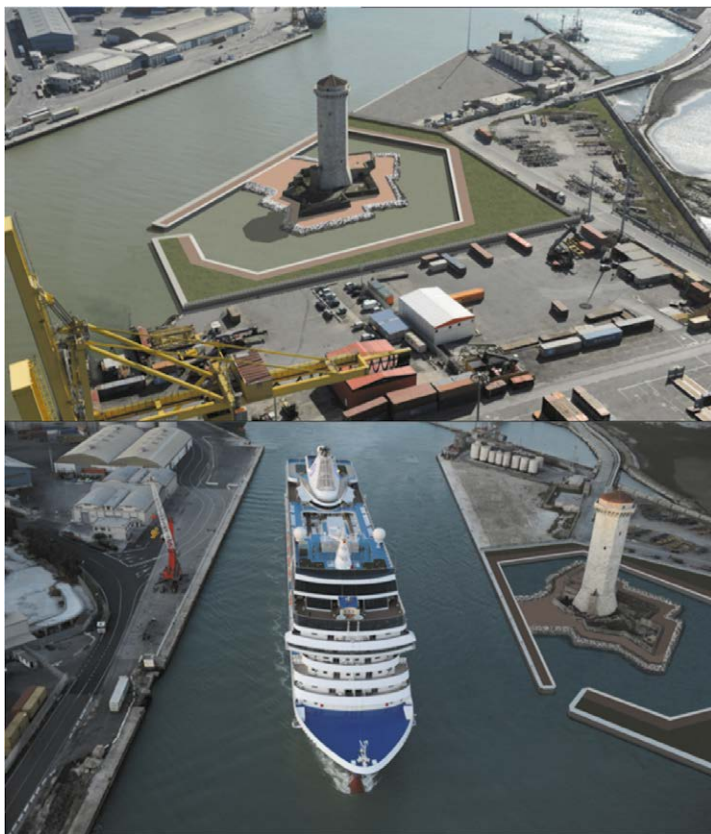


Figure 8 – Rendering of the restoration of the water basin around the Marzocco Tower.

With the completion of works on the water basin, it will be possible for craft of suitable size to sail around the tower, so that it can be seen from the sea in complete safety.

Again, and for reasons related to safety of navigation within the port and for the mooring of vessels in the Tower area, access to the internal docks was located in a position



at the south end of the west bank of the Toscana Docks where there are protected berths for vessels that are too large to enter the Docks themselves. In addition, this berth will not interfere with navigability around the turning basin.

It should be pointed out that the present project covers the construction of the embankment alongside the access channel, while completion of the future tower water basin will take place at a second time, after the Conservative restoration and consolidation works on the tower foundations.



Figure 9 – Phases for the works of the water basin. (\*) Conservative restoration and consolidation” of Marzocco’s fortification.

This layout is in line with what the Soprintendenza stated, “... must be implemented by the Livorno Port Authority, a project to restore the water basin around the Marzocco Tower, an octagonal monument dating to the 15<sup>th</sup> century, in accordance with Law 1089/1939, to be presented to the competent Superintendence of Pisa and the General Direction for landscape, fine arts, architecture and contemporary art, in order to reconfigure the original appearance of the area and maintain the prospect on the side of the sea”.

## Conclusion

Several technical insights commissioned by this port Authority have allowed to examine in depth the history and structural details of the Torre del Marzocco.

Thanks to this project, the North Tyrrhenian Sea Port Network Authority has proposed a solution which includes the restoration of the water basin around the 15<sup>th</sup> century tower, with approval of plans by the office of the “Soprintendenza for architectural and landscape assets, for historical, artistic and demo-ethno-anthropological heritage for the provinces of Pisa and Livorno”, as well as increased safety of container ships’ access and traffics of the port.

This project will allow a viewing point between the Tower (symbolising history and tradition) and the channel to today’s modern Port (the present and future).

The new trend clearly shows the essential role that this heritage plays in the sustainable development of ports and in the resolution of conflicts in the port-territory relationship.

In this respect, the work planned in Livorno for the next three years involves a number of projects, such as restoring the original moat around the Old Fortress, the

renovation for new functional uses of the Livorno grain silo or the restoration of the harbour defence fort. In this context, restoring the original water basin and turning Livorno's Torre del Marzocco into a museum represent one of the most important safeguarding, restoration and reuse projects.

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