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Traces of the fortification past from poor ruins: the extreme case of Torre Flavia

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Abstract

The robust network of towers along the Mediterranean coast has seen very various destinies, from well-preserved to reused, to damaged, to partially or destroyed. The case of Torre Flavia, along the coast of Lazio, Italy, stands between those reduced to ruins. Torre Flavia is a medieval coastal defence structure. It was restored and fortified by Cardinal Flavio Orsini in the XVIth century. The Allied bombing in 1943 severely damaged the tower, destroying the upper floors. Today, cannon openings resembling windows remain visible. In addition, this tower's specific position clearly shows how natural events may consume the original robust building into poor remains. This tower may be seen as a symbol of the long run of human events and the evolution of warfare, with this building standing for a long time on the seaside until the new weapons of the aerial war strongly damaged it. In the present proposal, a virtual reconstruction from the ruins will be attempted starting from the digital survey of the remains, from the analysis of the available sources, and interpolating reference models. In this way, a possible original aspect of this unlucky tower will be produced to support a better knowledge of this architecture.

Keywords: decay, digital reconstruction, Lazio, Ladispoli.

1. Introduction

When Torre Flavia was erected, it was built atop the remains of a Roman maritime villa (Enei, 2006), the tower and the surrounding area is well-documented by historical representations and in photographs since the early XXth century (Paliotta, 2006). The logic of reuse applied for the tower is a classic from this kind of intervention. In this specific case the regular remains left by the villa appeared a perfect basement to raise up a tower on the sea. The villa's structure consisted of long rectangular rooms, aligned Northeast-Southwest, measuring over 15 metres in length, and preserved up to a height of one metre and a half on the southern side of the tower. Brick and reticulated limestone, which are common materials for Roman villas along the shore, were used to build the walls. Later, coastal erosion ruined the villa (Tortora, 2020). Understanding *Torre Flavia*'s architectural layers and the larger coastal defensive system to which it belongs (Turco & Isgrò, 2018) depends on a preliminary understanding of the relationship between materials, decay, evolution of the landscape. Since the first century AD, the Lazio coastline, which is dotted with important communities and natural features (Gallico & Turco, 2018), has been essential for marine defense. To protect important Roman settlements like *Ostia, Lavinium*, and *Astura*, defensive construction started (De Rossi, 1971). Watchtowers were erected on rocky promontories or close to fortified communities such as *Castrum Neptuni*, *Castrum Pratica*, and *Castrum Fusani* during the IXth century as a result of increased fortification efforts spurred by the danger of piratesque incursions first and then of Saracen invasions. Later, in the modern restructuring of the coastal fortifications, these defensive efforts were

integrated into the larger coastal defence network organized by the Papal States during the XVIth century, particularly under Pope Pius V, who issued the *Constitutio de aedificandis turribus in oris maritimis* (1567), aimed at strengthening coastal fortifications.

Fig. 1- Evolution of the coast around Torre Flavia, 2002-2024 (Google Earth).

Torre Flavia was rebuilt during this period, entering as a part of this strategic system.
By 1603, the tower was not yet armed with cannons. However, by 1631, it was well-armed with a metal falconet, mortars, muskets, and other weapons. By the 1800s, the tower had two 12-gauge guns and three rifles with bayonets.
It had *peperino* slab flooring, intact parapets, and a signalling furnace (Gruppo Archeologico del Territorio Cerite e Comune di Ladispoli, 2010).

Being near marshes and the *Vaccina* River made Torre Flavia a prime location for coastal surveillance. It could easily control shipping and protect the nearby settlements from this vantage point. However, it was a component of a larger system rather than a single tower standing alone.

Fig. 2- Postcard published in 1970, matching the tower in the thirties and in that year (Source: https://www.prolocoladispoliaps.it/torre-flavia/).

Other Roman locations along the shore, such as villas close to *Fosso Turbino* and the well-known route *Aurelia*, one of the main Roman thoroughfares, were connected to the tower. These sites probably used simple signals like smoke or fire to warn each other of danger. In this way, Torre Flavia was much more than just a lonely outpost; it was a key part of a defensive system that helped the Papal States secure the coastline.

Fig. 3- View of the tower in its present conditions.

2. A series of unlucky events

The main danger to Torre Flavia's preservation has been the substantial erosion it has experienced over time (Di Bella et al. 2020). This phenomenon was probably yet ongoing at the time of the Roman Villa, thus the strategic interest in keeping such a crucial location pushed the military choices to create the fortification ignoring the adverse environment conditions. The sea has gradually eroded the reminder of villa underneath the tower, which was visible in the early 1900s. The majority of the villa has vanished, leaving only the bottom portion standing today. The erosion action has mined the

basement of the tower (Tartara, 2020), thus it is clear that the gradual process of decay had a dramatic acceleration when the tower was bombed during World War II. In the long list of fortifications experiencing the evolution of weapons, the tower was destroyed by an air attack that caused the fall of the central parts of the vaults, opening the core of the building and leaving the tower to its four massive corners.

Fig. 4- View of the tower from the distance in its present state.

In the urgency of post-war reconstructions, the tower was then neglected, with the four angles arriving in recent years in a reasonable condition, but kept as picturesque separated fragments, maybe imagining that the integrity of the structure was secondary in the overall presentation of the remains. So wrong, the alteration of the basement operated a gradual twist on each part, and in the turn of few years the four corners bent on the other, creating a weird composition of massive fragments, one bearing on the other. Recent restoration efforts have concentrated on stabilizing the tower and halting additional harm from coastal erosion and rising seas to help protect it. Given the ongoing encroachment of urban development on the site, these initiatives appear essential for preserving what remains. The transformation of the environment is extremely evident (Fig. 1), from an original condition that made it realistic to realize a Roman Villa in front of the sea, the gradual erosion left ruins for erecting the tower, then the ongoing natural transformation of the coast brough the tower to be flooded and appearing like rising on the sea (Tortora, 2020). After the destruction caused by the war (Fig. 2) the restoration tentative brought to reintegrating the soil around the tower, recreating a scenario probably similar to the time of the tower's foundation. In the present, the indication to the tower describe just a poor set of ruins, isolated by a miserable fence to keep away people from the risk of possible falling fragments (Figg. 3, 4).

3. Digital Survey

As Torre Flavia continues to be affected by coastal erosion, modern digital technologies have become a lifeline for preserving documentation of what remains. Photogrammetry can describe with an expeditious and efficient method the dramatic state of the remains, creating detailed bases for 3D modelling to develop proper reconstruction integrating the variety of graphic and photographic witnesses left from the past (Russo & Remondino, 2012).

Fig. 5- Survey operation, ground level shooting.

So it was decided to develop an autonomous intervention of digital survey and reconstruction for this architecture in its precarious state of balance between abandon and failed tentative preservation. In the specific case study the photogrammetry was operated completely from the ground using two Fujifilm mirrorless cameras. The Gfx-50s, with a medium format 50 Mp sensor, was used for all the handheld shots, moving along the perimeter of the tower (Fig. 5).

Fig. 6- Photogrammetric processing in EG Reality Capture (graphic elaboration by the authors, 2024).

The lens, a Fujinon 32-64mm F4 zoom lens (equivalent to a 25-50mm on a full frame sensor), was used at 64mm, and stopping down at F8 (in backlit and shadows) and at F11 (in direct sunlight). The overall campaign was planned taking a generous number of shots, with a total of 732 pictures, which allowed to cover all the surfaces of the exterior, but also almost all the internal parts, which were revealed little by little while the process of shooting was ongoing. To enhance the coverage of the top part and reduce the occlusions in the higher elements, a secondary sequence of shots was taken using the lighter XT-100 equipped with a Fujinon 15-45mm F4 zoom lens (used at 17mm focal length) on a 26 Mp APS-C sensor. The camera was mounted on a telescopic pole capable of 8.5 metres of extension and remotely controlled by a smartphone. An efficient solution that may replace the need for a drone/UAV intervention for small architectures (Fiorini, 2012; Russo, 2020). In this way two full rings of shots at different heights (one at about four metres, the second at about eight metres) were realized, producing 272 pictures. Following some direct measurements were taken on the external walls to allow the scaling of the final model.

To better document the present state of the landscape around the tower, a series of fully panoramic pictures were taken using an Insta360 Pro II camera, capable of taking 8K shots with a full 360° field. These image set was then used to create a simple virtual tour connecting contents developed during this research and made accessible at the URL: www.didalxr.it/torreflavia

4. Data treatment

All the shots coming from the two cameras were later checked and then loaded into EG Reality Capture software to enter a classic SfM/IM processing. The alignment, done in a single operation, producing the point cloud using all the shots in a single component. The following polygonal mesh resulted in 217 million triangles, then simplified to 14,9 million. The texturing was built using an adaptive atlas, to exploit the best quality and have it fully available in the final result (Figg. 6, 7, 8). The resulting model was then used for producing an exportable version in OBJ format for further processing and a complete sequence of high resolution orthophotos presenting the main four fronts of the tower and a series of sections showing the inner fronts of the remains of this unlucky architecture. To complete the process and help the access to the produced data, an even more simplified version of the mesh was created, down sampling the overall number of polygons to just two million and recalculating the texturing with just four 64 Mp atlas maps, the textures were compressed to reduce even more the final size of the model and upload it to the sketchfab.com platform.

Fig. 7- Orthophotos of the southern and western fronts of the tower (authors, 2024).

Fig. 8- Orthophotos of the northern and eastern fronts of the tower (authors, 2024).

5. Digital reconstruction

The state of conservation of the tower shows the collapse of four corner remains and an internal component of a wall. In order to obtain a more scientifically based reading, a digital reconstruction process was performed, constituting a state of virtual reconstruction useful for the geometric study of the artifact. The operation proceeded with the repositioning of the five recognizable portions in their previous condition, rotating and moving each component in order to obtain alignments based on a secure geometric matrix obtained from the few documentary sources, consisting solely of historical photographs. The main alignment axis is recognizable with the horizontal line described by the low string course of the elevations, distinguishable in the remains with the string course moulded frame passing on the lines of change of inclination of the elevations, between the low sloping wall and the development of the vertical masonry wall of the body of the tower. Only the rotational alignment of the individual portions defined their azimuthal orientation. This first operation highlighted how one of the four corner parts was the least affected by the dynamics of collapse, guiding the choice to set it as a constraint in the subsequent transaction operations.

The operation proceeded with the study of the planimetric geometry. The first distance reconstructed is that relating to the transverse development, verifiable with the alignment of the impost traces of the barrel vault of the lower room (corresponding to the portion of the sloping wall). The reading of the transverse section allowed the recognition of the regular geometry of the semicircle describing the round arch of the barrel. In all four portions involved in the translation, a planar movement was performed to the transverse section, based on the portions of the impost of the vault that were largely present and on which the curvature was observed and aligned. Once the transverse dimension was found, the following

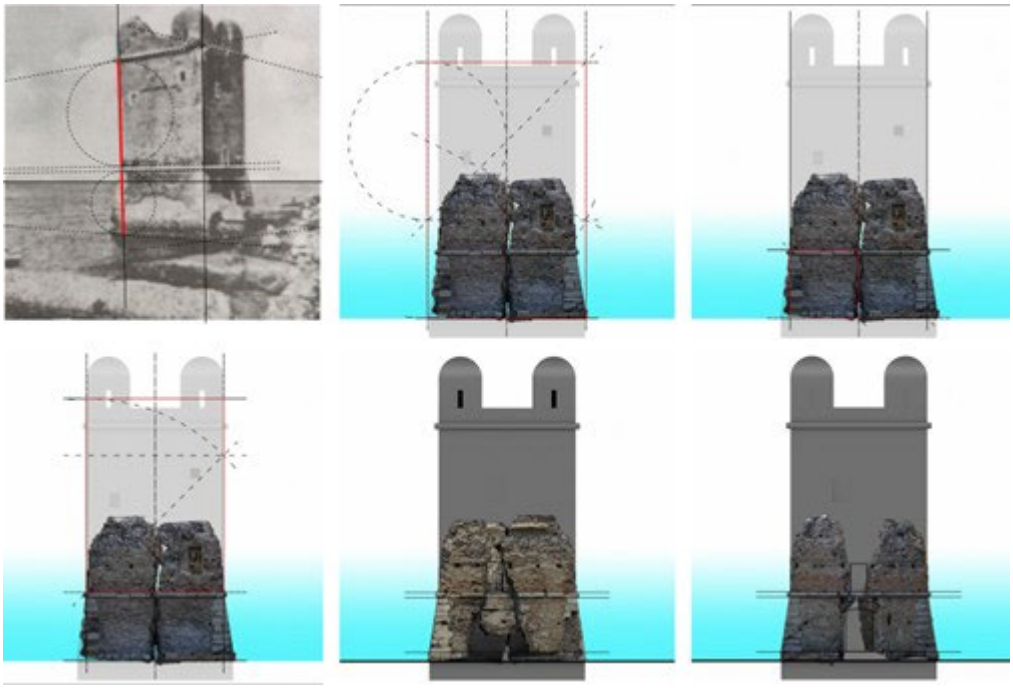

Fig. 9- Phases of the digital reconstruction (graphic elaboration by the authors, 2025).

reconstruction focused on the longitudinal development, completing the layout of the plan. The ideal geometry of the barrel vault does not allow the determination of its development with certain geometric scheme components. We operated with the choice of the most certain, admitting this as the hypothesis with the smallest margin of uncertainty.

The reading presented therefore describes a development of the tower on a square plan, justified mainly by a comparative analysis of contemporary examples of coastal towers in the area. The alignments, obtained with translations parallel to the longitudinal axis of the four components, have reconstituted the final configuration of the horizontal section profiles of the wall, defining the initial setting, read from the old postcards that reproduced the tower before the slides (Figg. 9, 10).

These operations were conducted using Maxon Cinema 4D, importing the OBJ model with texture produced by digital photogrammetry process and then performing operations on the polygons and subsequently rotations and translations to achieve the desired repositioning. The management of the software environment with a timed organization of the operations allowed the obtaining of an animated environment, which proved to be greatly helpful in controlling the movement of the parts, managing the temporal sequence, for the improvement of the inclination and sliding of the components. The final state, in addition to being the basis for the definition of the complete layout of the tower elevations, offers an animated elaboration of the sliding sequence useful for observing its dynamics (Fig. 11).

It is therefore highlighted how the alterations of the layout of the first remains of the artifact mainly follow the influence of the forces produced by the wave motion of the sea and finding a still active collapsing process, because it refers to the current state of the tower without adequate consolidation.

6. Conclusions

Torre Flavia is more than just a tower; it is a symbol of the complexity of coastal protection throughout history. The tower, which is a component of the wider Lazio coastal defence system, is a reflection of the military tactics that influenced the area from the Roman era to the

Renaissance. Its proximity to critical Roman roadways demonstrates how crucial it was to keep an eye on and safeguard the maritime routes. Operating on Torre Flavia's virtual documentation may now serve as a reminder of the continuous battles against decay and environmental change, which endanger other coastal heritage sites.

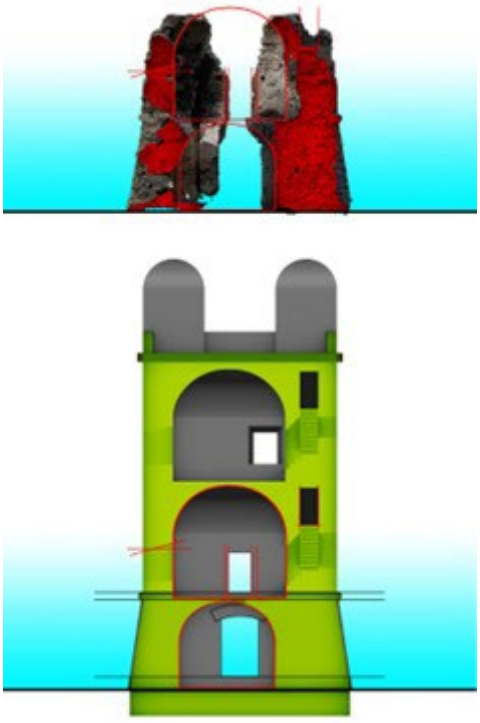

Fig. 10- Digital reconstruction of the Tower's transversal section (graphic elaboration by the authors, 2024).

Torre Flavia is still a significant historical and architectural landmark in spite of its fragmentation. It is a priceless example of coastal defense and fortification design.

At the same time, the digital reconstruction shows clearly how massive was the loss caused by bombing, reducing the tower to ruins left to neglect until they reached a completely compromised condition. While it seems difficult to see the tower really recovered into a proper future physical preservation intervention, the creation of a complete dataset documenting the state of the ruin and expanding the digital data to a gradual reconstruction, with the rectified fragments and then with the reconstructed volume, looks like a decent alternative to support further study and maintain a trace. For this, all the resulting dataset are now included in the Figshare platform, catalogued with a DOI identifier and directly accessible to other scholars and curious. The dataset includes the group of high-resolution fronts and sections, the fronts in rectified setup and the reconstructive drawings, all made available in full resolution in PSB, TIFF and JPEG formats.

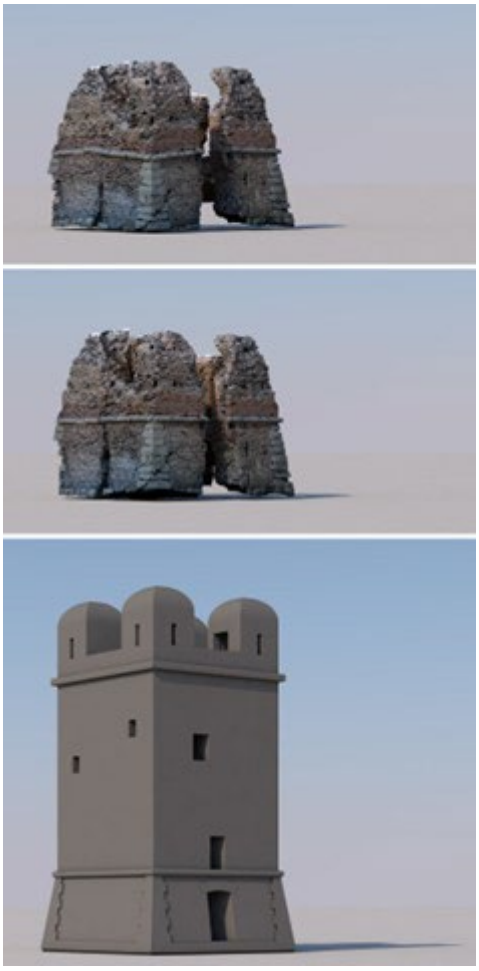

Fig. 11- Digital reconstruction of the Tower: the present state, the re-alignment of the ruins, final reconstruction (graphic elaboration by the authors, 2024).

The simplified 3D model is freely available on sketchfab.com while the full resolution 3D model and Photogrammetry project are available on demand from the authors. A small contribution to

the (at least) digital preservation of this valuable architecture before its loss (Fig. 12).

Fig. 12- QR code for direct access to the Figshare dataset and direct access to the 3D Model in Sketchfab.com (elaboration by the authors, 2024).

Credits

The presented results have been developed as personal research coordinated by prof. Giorgio Verdiani, in teamwork with Alexia Charalambous and Andrea Pasquali, the research group operated with the support of the Didalabs System from the Dipartimento di Architettura, University of Florence, and in the specific with the Extended Reality Laboratory (DIDALXR) and the Photo and Video for Architecture Laboratory (LFVA). All the parts of the present paper are the result of a fully collaborative work with collective authoring. Graphic contents, where not differently specified, are by the authors.

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