24 DEFENSIVE ARCHITECTURE OF THE MEDITERRANEAN

Michele RUSSO, Marta ACIERNO (Eds.)

DEFENSIVE ARCHITECTURE OF THE MEDITERRANEAN

Vol. XXIV

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Consistence of memories and lightness of the present: the Rigena Tower in Larnaca, Cyprus

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Abstract

The contemporary tall fence around Rigena Tower in Larnaca (also known as Kiti or Perivolia Tower) isolates and protects the landmark from visitors, damage, or overexposure. Though not exceptionally tall, the tower commands attention from its position atop a prominent cliff, with a solid base and a restored top, standing out in an otherwise secluded landscape. This physical and symbolic separation, coupled with its various names, creates a surreal quality in which the tower's identity becomes elusive. Conflicting online information and fragmented stories further obscure its real presence, despite its material solidity. Historically, the tower dates back to the Lusignan period (1092–1474), likely constructed by the Venetians to defend the Pervolia area. After centuries of neglect, it underwent significant restoration in the early XXth century, which largely shaped its current appearance. This contribution views the tower's isolation as an operational challenge, using it as a case study in research-oriented architectural survey. Building on prior investigations, the focus is on distinguishing restored components from original remains through a combination of graphical analysis and virtual reconstruction of lost elements. A photogrammetric survey was conducted, employing both new photography and crowdsourced images and videos found online. This comparative approach yielded two models - one from a direct survey, the other from online data - demonstrating how internet-sourced material can support documentation in challenging contexts. The results form a foundation for further reflection on the architectural proportions and possible reconstructions of similar towers in the historical defence network of the region. The combination of physical isolation, historical ambiguity, and digital methodologies opens a discussion on how such structures can be understood, documented, and virtually reconstructed to preserve their architectural and cultural significance.

Keywords: kiti Tower, pervolia tower, lusignans and venetians, photogrammetry.

1. Introduction

The Kiti Tower (also known as the Rigena Tower or Pervolia Tower) is one of the few surviving Cypriot coastal watchtowers from the Venetian period (1489–1570) a part of a system in the complex strategies of control and expansion in those years in the Mediterranean (Molin, 1995;

Edbury, 1999). It stands on a low hill approximately twenty metres above sea level, less than two kilometres North of Cape Kiti, overlooking the southern coast and the Larnaca Salt Lake (Fig. 1). The site is accessible via an unpaved road from the village of Pervolia, connecting to the coastal track leading to the lighthouse at Cape Kiti. The oral tradition recounts that Queen Rigena, wife of King Peter I of Cyprus, frequently visited this Tower, which was later named after her (Rigena Tower). Then, the popular tales liked to imagine Rigena spending her time there while the king was away on naval campaigns against enemies and pirates. The idea of the presence of such a historical figure grew into legend in local folklore. One of the popular tales recounts an underground tunnel that Rigena used during raids or to access the Tersefanou Baths. She is said to have travelled in a golden carriage with her guards, and some say that carriage lies buried beneath the passage. A traditional issue, the one of "underground tunnels", is quite recursive in human imagination, especially when rediscovering old buildings, which here meets a curious connection to an imaginative treasure. In its historical concreteness, the tower is known for being constructed between 1562 and 1563. It formed part of a chain of coastal observation posts designed to monitor maritime activity and secure the island against Ottoman incursions and piracy in the Eastern Mediterranean (Coureas, 2021). According to a Venetian document, the overall cost for the construction of the tower was 400 ducats (Castronovo, 2021).

Fig. 1- View of the Tower in the landscape

This defensive chain included the towers of Xylofagou, Pyla, Alaminos, and, according to Camille Enlart a now-lost tower at Amathus (Enlart, 1899) (Fig. 2). About the Kiti tower, Enlart describes it as constructed no earlier than the late XVth century. For this period, it is Enlart once again to suggest how military architecture in Cyprus -as well as ecclesiastical architecture- shows a predominantly French (Lusignan) character, he defines three main types: the first is represented by mountain castles with irregular layouts shaped by the terrain, as at St. Hilarion, Kantara, and Buffavento; (Enlart, 1889) the second sees lowland castles built on a regular rectangular plan with four corner towers, the commonest standard plan in France, seen at Semur-en-Auxois, the Bastille, and Dourdan, whose design descends from the Roman or Byzantine castrum and was adopted mostly at Kyrenia (Camiz et al., 2016) and Famagusta (Cosmescu, 2019); and third, the simple towers, either isolated or with minor outworks, as in the system underlined by Enlart of Cape Akama, Kolossi, Kiti and Pyla. He considered the four towers together with a fifth, at his time still traceable on the beach at Amathus, served as a coastal watch post. Probably, this system also included the tower at Alaminos, about 13 km West of the Kiti tower. More than one century later, the reading of the towers' network is not simpler because of the incremented decay, thus, recent studies have shown a more extended defensive system (Petre, 2010; Doukanari, 2024). Nowadays, it is possible to suppose that in the time of its use the view from the covering of the Kiti tower could sweep West toward Mazotos and Alaminos, East to the monastery of Stavrovouni, and -on clear days- across the Kokkinokhoria to Cape Pyla, where the Xylofagou tower stands (Alexandrou, 2017). In this landscape, the towers of Xylofagou, Kiti, and Alaminos likely worked as a linear watch–signal chain: lookouts identified sails, then relayed warnings by beacon fires (and probably smoke by day), with messengers on horseback or by foot carrying alarms inland. The good visibility over the horizon and the extended sight on the landscape made the tower both an efficient sentinel and a significant landmark, functioning as a part of an early-warning network and as a means of asserting Venetian control over the southern littoral of Cyprus.

2. Architecture of the tower

The Rigena tower may appear as a simple building, not that monumental, thus rich of fascinating elements and with a series of specific stories worth being studied. Its importance as a key watchtower and a territorial signal brought the need of quality in the construction and some symbols underlying the significance of this architecture. The architectural structure of the

tower has a square plan layout, with three different spaces at different levels. The main use of sandstone made it well balanced in texture and colour with the natural landscape. The base is well defined by a bold masonry with a slope wall, which has a length of about eight metres per side. The blocks have a height ranging from 25.5 to 32 centimetres in the base and from 25 to 34 in the straight elevation of the upper level.

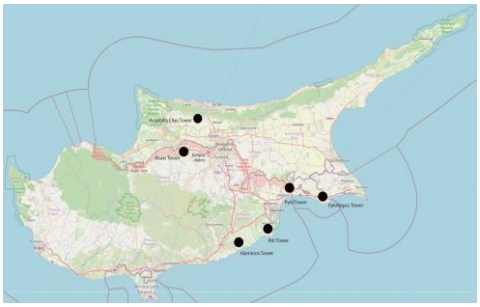

Fig. 2- Map of the towers' network remains

The ground floor has no openings, enhancing defensibility. In the interior it was realized a water cistern, capturing rainwater from the terrace, for sustaining a small garrison during extended periods of surveillance, its internal access is still preserved. The masonry becomes vertical at the upper level. The sole entrance is located on the West façade, four metres above the ground, according to the most classic solution for this type of building, allowing access only via a rope or wooden ladder. The opening gives access to a vaulted chamber with a square layout, where the body of the tower is measuring approximately six metres on the outside, while the inner space is of about 3.85 metres. The original timber floor has not survived but was replaced during restorations. Internally, a narrow built-in staircase ascends from the entrance to the terrace.

This wide observation point is delimited by continuous decorative cornice probably with machicolations beyond the wall face, supported by carved stone corbels. This feature, found on similar XVth and XVIth century coastal towers in the Kingdom of Naples, allowed defenders to protect the base of the tower. The rooftop probably encircled by machicolations (Fig. 3) extended the top terrace and probably supported a wooden parapet. Two sculpted waterspouts were installed on both the East and West ends of the coverage. The terrace has also a significant modern integration: a point of the Cyprus Topographical National Network, signalled by a truncated pyramid built on a concrete base and with the writing *Cape Kiti Trig Point* in English, Greek and Turkish.

Fig. 3- Detail of the top part

3. A strong symbol over the landscape

Above the west-facing entrance there is a single marble panel bearing three Venetian coats of arms. The relief presents a marching (*andante*) Marcian Lion, described in the source as an ensiferous lion -bearing a sword- turned to the left and of the "standing" subtype (Rizzi, 2012). It is carved in limestone (panel 35×60 cm; with frame 35×90 cm), with a toroidal mould. The lion shows parallel wings, a streaming tail touching the forepart, and -at the far left- a rise with a tower (Fig. 4). The modelling is shallow, and the piece survives in poor condition due to erosion. Flanking compartments hold two shaped shields: the shield to the left, displaying three roses within an inverted chevron, belongs to Zuan Mattio Bembo, *Provveditore Generale* of Cyprus, who oversaw and financed the completion of the tower in 1563 (Saminet, 2011). The shield to the right, bearing a simple diagonal band, represents the Gradenigo family, likely acknowledging the contribution of Marino Gradenigo, Lieutenant of Cyprus (Patapiou, 2017). This heraldic decoration provides a valuable insight into the Venetian administration of the island. The presence of the Bembo and Gradenigo family coats of arms, alongside the Lion of San Marco, suggests a construction or restoration phase between 1561 and 1564 (Patapiou, 2006; Castronovo, 2021). The Venetians used to place official symbols of the state, as well as the coats of arms of noble families financially contributing to these constructions. The representation of the Lion may be the subject of some reasoning about its symbolic value. The

sword appears clear in the right hand/paw, but there is no trace of the classic book/gospel. In the current state of the relief, the area beneath the lion's front paw is worn and lacks clear details. No conclusive evidence confirms whether a gospel was originally present near the left paw, as in some configurations of this symbol of Venice, thus, the rare, but not inconsistent, habit in presenting the Marcian Lion with the sword only may validate this originality in a military context where the presence of the sword is a common subject compliant with known variants of the Lion used in defensive settings of the Venetian architecture.

Fig. 4- The marble panel in 2016, 2020, 2025 (Lygeros, N., Merseburg, G., the authors)

Most of all, the conditions of the stone, exposed to sun, wind and weathering, appears quite concerning with the evident need of a restoration interventions before the sculpted elements may suffer further decay.

4. The tower in the present

By the late XIXth century, the tower had suffered extensive deterioration, largely due to the removal of stone by local villagers. During the period of abandonment, it is possible to imagine a variety of accesses with the typical behaviours of occasional visitors. It probably belongs to this phase the presence, in the entrance door, on the threshold, of some scratched inscriptions. However, due to significant surface erosion and weathering, the text is heavily degraded and poorly readable. Multiple photographic enhancements have been attempted on the pictures taken with the UAV on these writes, but without producing a readable transcription. The tower was declared an Ancient Monument in 1905 (Fig. 5), it gained conservation attention probably between 1911 and 1912. This happened after a photograph documenting its deteriorated state was published by the Society for the Protection of Ancient Buildings (SPAB). The image revealed damages at the base, caused by stone removal. Thus, stone removals, using the tower like a quarry, were documented since 1878 (Jeffery, 1918). British architect George H. Everett Jeffery, then Curator of Ancient Monuments in Cyprus and SPAB member, led stabilisation works. Both traditional stonework and concrete, were used to ensure structural stability, an approach criticised by SPAB purists for departing from conservative restoration methods. The tower underwent further restoration in 1977, (Polignosi, 2025) the concrete previously used to substitute missing stones in the lower part was removed, and all damaged sections were reconstructed using stonework.

Fig. 5- The tower in the early XXth century (Author unknown)

The entity of the replacement work was already well analysed in previous studies (Konstantinidou, 2022) and shows a relevant integration of the basement, the sketch from Enlart (Fig. 6), realized more than 20 years before the first restoration shows large missing parts which probably were even more compromised in 1911. The use of concrete can obviously be criticized in choice of the material, but it probably saved a situation close to irreversible breakdown.

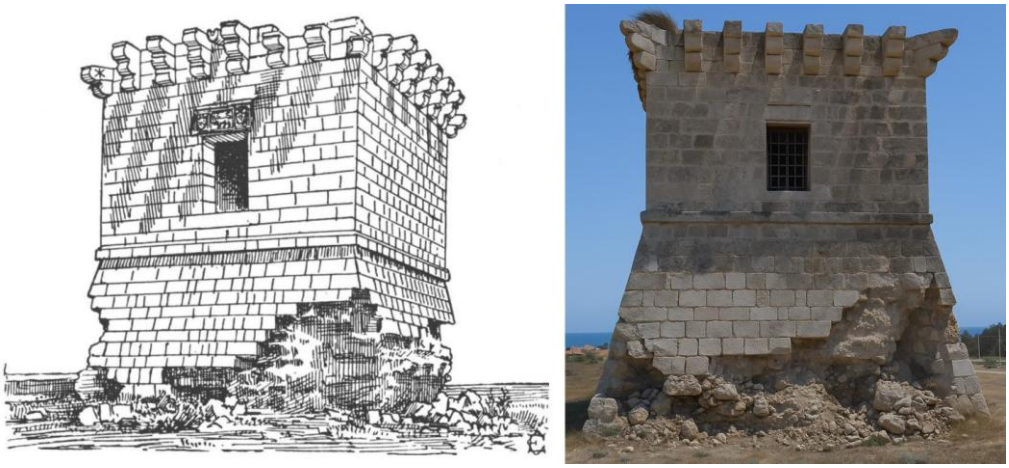

Fig. 6- AI reconstruction of the state of the tower before restorations (from a sketch by C. Enlart, 1889)

5. The present and a matter of horizon

Today, the Kiti Tower stands enclosed by a modern protective fence, visually and physically isolating it from its surroundings. While this preserves the monument from damage and overexposure, it also lends the site a sense of separation from the landscape it once commanded as part of a dynamic coastal defence system. The presence of some recent solar panel and plants does not help in making more contextualized this architecture. The horizon line is the apparent boundary where the earth's surface and the sky meet, thus the amount of houses between the hill of the tower and the seaside alter in a significant way the aspect of the landscape at the time when the tower was built.

Geometrically, it is the set of points of contact with the curved surface of the earth as seen by the observer's eye, so that its distance - and the slight inclination below eye level - depends on the observer's altitude and atmospheric refraction (Proctor & Ranyard, 1892). The visible sea horizon is not depressed by several degrees as popular estimates frequently imply; rather, it falls quite little below the true horizontal, rises with the square of the distance, and is naturally mitigated by atmospheric refraction. There are two comparable methods for estimating the sea horizon in practice (Sweer, 1938). According to the unit-depression rule, the angular dip at n miles is $D=n^2*d$, where d is geometrically equal to eight inches per mile (or ≈six inches per mile when ordinary refraction is considered). The distance increases in proportion to the square root of the eye height, as shown by the geometric formula s [km] $\approx 3.57*\sqrt{h}$ [m] (geometric) or the refractive formula s_opt [km]$=3.86*\sqrt{h}$ [m] (with refraction). If the goal is also elevated, the roots have to be added: $s \approx 3.57*(\sqrt{h_1}+\sqrt{h_2})$ (or 3.86 with refraction); where, s is the distance to first visibility, and h, h_1, and h_2 are heights in metres. The Kiti tower stands approximately eight meters on a hill; at parapet level, it rises almost 28 meters above sea level. The appropriate horizon is then about 18.9 kilometres, using conventional refraction yields an approximate distance of 21.8 kilometres, confirming with some minor *performance* the visual range defined in other studies (Arcgis, 2025). The same metric rule still applies when a vessel is sighted reciprocally: for a 10 metres masthead, the first contact of visibility occurs at ≈30.2 kilometres (geometric) or ≈34.9 kilometres (with refraction); for a 20 metres masthead, the ranges are ≈34.9 kilometres and ≈40.2 kilometres, respectively. The practical limits of the watch from the tower toward the open sea can be fixed using these values, which are derived immediately from the straightforward square root dependence. The use of an online calculators (Borchia, 2024) has confirmed the computation. The positioning of the tower then, well exploits the height just to reach a proper efficiency in controlling the seascape, while keeping compact the architectural structure, well working in terms of self-defence with robust walls and with a lowered height that make it capable of gaining time between sighting and starting the alerts and countermeasures without the need of stepping down a long staircase.

Fig. 7- Orthophotos and sections of the tower with QR code for accessing the full graphic board

6. Digital survey of the tower step one

The forced condition of isolation of the tower was taken as an operative challenge in a survey aimed to support productive research. Also moving from previous studies, the forbidden access was considered as an opportunity in testing a complex situation, more than a limit to gathering proper data. Previous surveys of the tower are already published and even available online (DigiArc, 2024), thus a certain weakness in the level of details and the intention of bringing on the survey as a challenge brought to two productive tentatives. The first step was testing the option for operating the survey on the base of available pictures gathered from the Internet. The main "crowdsourcing" dataset was collected from publicly accessible imagery (photographs published on the web and frames ripped from YouTube drone videos) and then processed in EG RealityScan 2.0. The image data lack of controlled overlap, present random variation in focal lengths, is often missing EXIF data, and suffers from excessive destructive image compression. The presence of sparse vegetation further lowering tie-point density without helping the reconstructive process. To this series of issues, the North and East fronts suffer from poor attention from the visitors. As a result, the polygonal surface and texturing is noticeably softer, noisier, and metrically untrustworthy. Therefore, this crowdsourced model should not be considered as a proper base for accurate measurement or deformation analysis nor for a pleasant view, but rather as some sort of simple enrichment for neogeography content. The result can be checked in Sketchfab.com at the link: https://kutt.it/ydc5K9

7. Digital survey of the tower step two

After the modest result based on crowd sourcing, the following phase was planning a direct photogrammetric survey in place. Other studies have already experienced the issues of taking pictures from behind the fence (Konstantinidou, 2022), but some integrative solutions (use of a UAV, use of a slightly telephoto lens, small evolutions in SfM/IM software) may help in reaching some enhancement in the final results. The aerial photographs were taken with the DJI Air 2S drone. This is a compact yet very effective solution for aerial surveying. It is equipped with a one-inch CMOS sensor delivering 20MP still pictures. It also supports 10-bit D-log and HLG colour profiles, which allow better post-processing flexibility in workflows for Built Heritage visualisation. The integrated obstacle avoidance system enhances flight stability and operational safety in complex environments. For the terrestrial SfM/IM photogrammetry it was used the Canon EOS M50 Mark II that is a lightweight and versatile mirrorless camera. It features a 24.1 megapixels APS-C CMOS sensor.

With ISO sensitivity ranging from 100 to 25,600, the camera may accommodate a variety of lighting conditions keeping a reasonable level of sensor noise. The terrestrial photogrammetry shooting was operated all around the fence, taking two round turns at two different focal lengths (full wide angle at 15mm and tele-lens at 45mm equivalent to 24 and 72mm in full frame format) to have a larger set of options in reconstruction. The UAV operated from the perimeter of the fence and moved around the tower in manual mode. In total, 129 aerial shots with GPS positioning and 785 terrestrial shots were used to post-process in EG Reality Capture 2.0 and obtain a textured 3d model. In order to verify the scale of the model, a measurement from a large element on the perimeter of the fence was taken.

8. Digital Content Production

The following post processing was aimed at producing a 3D detailed model of the tower, well describing the situation of the building in all its fronts and on the coverage and a set of orthophotos at the highest possible resolution. The classic SfM/IM photogrammetry process allowed the production of a full mesh of about 124 million triangles with texturing in high resolution, once scaled it allowed taking measurements for morphologic aspects (like the size of height of the stones) and producing an architectural graphic board with all the main fronts and view of the coverage extracted as orthoimages at a resolution of about 36 thousands by 32 thousands pixels. A vertical section was produced using existing graphic materials and adapting them to the new survey. The result was then shared using the Zenodo.org platform, assigning a specific DOI and including here the QR code for direct access (Fig.7). A simplified version of the 3D model was then produced with a reduction of the triangles to four millions. This lighter 3D model was then exported in OBJ format keeping a reasonable quality in the texturing (one 16x16 thousand-pixels texture atlas) and in the end uploaded into Sketchfab.com platform allowing a public share of the model in high resolution. The 3D model is accessible using the second QR code in this paper (Fig. 7).

9. Conclusions

The Kiti, Regena, Pervolia, Tower is a classic example of landmark collecting stories, built for seeing and being seen, it keeps on capturing attention and focalizing curiosity. The variety of names it got in time is an evident consequence of its relevant presence. In the present, the use of digital tools seems just to disclose the fascinating set of research opportunities it contains, from the issues connected to the preservation, to its symbols and complex features.

The creation of quality digital contents, as done in this research work may allow a better support in studies and fix a state of knowledge for future multidisciplinary approaches in studies and interventions on this building.

With the hope in seeing, sooner or later, restored a free access and the entrance panel protected from a progressive natural *lionoclasm*, with a reestablished opportunity of visiting the interior and the terrace, completing and making popular and without risks the view from the tower to its extended landscape.

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