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Michele RUSSO, Marta ACIERNO (Eds.)



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Michele Russo, Marta Acierno
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Fortification, transformations, disasters, a complex vicissitude for the Krujë Fortress in Albania

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Abstract

The Fortress of Krujë has its first settlements about the VI century AD, it was then reconstructed and expanded in time until the contemporary age. It was the strategic base during the Gjergj Kastrioti Skanderbeg (1405-1468) rebellion against the Ottoman Empire (1443-1478), resisting three main sieges in 1450, 1466 and 1467. For being strategically involved in these intense historical events it stands in time as a symbol of the Albanian nation, gaining a specific importance during the Communist Regime (1944-1991) which brought to a series of restoration and integrations in the Eighties and to the construction of the Gjergj Kastrioti Skenderbeu museum and of the Ethnographic Museums. The earthquake in 2019 caused some severe damages to the structure of the fortress opening large cracks on the main watchtower, in the cliff on which it stands and in the vault of the Bektashi Tekke (a religious building realized during the Ottoman period). Immediately after the disastrous event, a unit from the Department of Architecture, University of Florence conducted a specific terrestrial and aerial/UAV photogrammetric intervention to support the emergency operations on the monument. Exploiting a previous survey made by members of the same unit in 2017, it was possible to check the state of the vault of the Tekke with extreme accuracy discovering some surprising phenomena that brought to some rethinking about the impact of the shakes on the building itself. The present contribution will present the methods and procedures adopted for the intervention and the results obtained thanks to the matching with previous surveys, underlining once more the importance of appropriate digital documentation and how digital heritage may act as a safeguard for the real built heritage.

Keywords: digital survey, Skanderbeg, photogrammetry, earthquake.

1. Introduction

Every tower has a double value, controlling the landscape, offering an extended high eyepoint, and being seen, establishing a significant

demonstration about who dominates and defends a territory. Thus, a tower is always a military architectural work, it has some concession to

architectural styles, but it is mostly a practical and efficient system thought for extending its view at the maximal horizon extension and on all the main and risky roads and paths which may bring enemies in the protected zone. While a tower is a sign in the landscape it soon became a landmark, a signal in the territory, seen from the distance, becoming a presence well recognized by humans. The existence in time of such a building is soon linked to a variety of factors: invasions, wars, changes in warfare technologies, may cause the transformation, partial or total destruction. So, in the span of some centuries, it is not uncommon to have towers reduced in height, totally destroyed or reduced to some ruin, or seeing them transformed or even well preserved by reuse or restorations. In the case of the castle of Krujë in Albania, the watch tower is still standing despite battles and earthquakes, simply changing its function from military observatory to clock tower and then into meaningful landmark, establishing a relationship with the complex urban evolution of the town external to the stronghold and with articulated changes in the urban tissue inside the fortress (Xhexhi, 2025).



Fig. 1- Gjergj Kastrioti in a portrait from 1508 (Marin Barleti, 1508) and in the statue in Skanderbeg square, Tirana

2. The Skanderbeg's castle

Gjergj Kastrioti (c. 1405-1468) named Skënderbeu (in Albanian language) and Skanderbeg (around Europe) was born from an Albanian noble family (Fig. 1), he became well known for his sustained resistance against the Ottoman Empire, and as a celebrated national hero in modern times (Biagini, 2021). When young, he was taken as a hostage by the Ottomans, converting to Islam and becoming a military commander. In 1443, he defected and returned to Albania, re-embracing Christianity and

leading a revolt against the Ottoman government (Clarke Moore, 1850). Skënderbeu's military strategy relied on guerilla warfare and his mastery of the rugged Albanian terrain (Frashëri, 2002). His primary stronghold was the Krujë castle, a fortress he successfully defended against three main Ottoman sieges, including those led by Sultan Murad II and Sultan Mehmed II. He united Albanian principalities into the League of Lezhë in 1444 and secured a series of key victories, such as the battle of Albulena in 1457 (Pisko, 2023). His resistance delayed the Ottoman advance into Western Europe, a well praised task, earning him the title Champion of Christ from the European christian countries. Skënderbeu's decades-long struggle against the Ottomans concluded for an illness.

He died of malaria on January 17, 1468, in Lezhë, Albania (Papadopulo-Vretò, 1820). After his death, the League of Lezhë crumbled, and the Ottoman Empire finally conquered Krujë in 1478, a decade after his passing. Skënderbeu's legacy became strong in his country; raising his figure as the main national hero, the black double-headed eagle on the Albanian flag replicates his crest and banner. The history of the Skanderbeg castle in Krujë is a long and storied one, stretching from the early Middle Ages to the present day.

The fortress's origins are estimated with a date back to the V or VI century, built by the Byzantine Empire on a strategic hill overlooking the city and controlling the landscape. The toponym Krujë (Croia) was firstly identified in the IX century, it is derived from the Albanian word *kroje* (water spring). Evidence of the existence of a fortified settlement dates to the XII century. Between the XIII and the XV century, the fortress underwent several interventions which transformed it into one of the most important fortifications of the region.

A certain amount of construction remains in the castle belong to the mid-XV century during the rule of Skanderbeg. It served as a key stronghold and was passed between various local rulers until it was conquered by the Ottomans around 1395. During the Albanian revolt of 1432-1436, an unsuccessful siege was led by Andrea Thopia to reclaim the castle. The XV century marks the most famous period for the castle, as it became the centre of the Albanian resistance. In 1443, Gjergj Kastrioti Skënderbeu, having defected from Ottoman service, seized control of the fortress. He reportedly used a forged letter from the Sultan to gain entry. It was here that he raised the red and

black flag with the double-headed eagle, a symbol that would become a national emblem. For over two decades, Skanderbeg used the castle as his base to launch guerrilla attacks and repel massive Ottoman armies. The resistance of the castle was remarkable, placed on a cliff at about 556 metres on the sea level, it is surrounded by steep rocky terrain which made the access to the walls difficult, with only two entrances that lead inside the castle. The scenes from that siege are depicted in a variety of representations from the following centuries, those from the first siege of Krujë in 1578 (Fig. 2) and from the second siege of Krujë in 1587 (Fig. 3) show bold walls with towers and even taking a generous poetic license, represent the massive presence of troops and the dramatic balance between attackers around the walls and besieged in the inside. The presence of a water spring inside the walled area was an extremely important resource, giving plenty of fresh water even during the sieges (Karaiskaj, 2016).

The castle's fortifications (Fig. 4), combined with Skanderbeg's tactical genius, allowed it to withstand three major sieges. The fortress, with its small but determined garrison, proved to be an impenetrable symbol of resistance.

3. The watchtower

The watchtower of the castle is still today a significant landmark (Fig. 5). The tower was officially recognized for its cultural value in 1948, it was later designated as a protected site by the State University of Tirana (1963) and the Ministry of Education and Culture (1973). It was originally perched on a rocky ridge overlooking the town, part of the fortress serving as a strategic stronghold. Its highest point included a fortified redoubt. Within its inner wall stood two quadrangular towers, one of which eventually became the present watchtower. Initially built between the XI and XII centuries, this structure is among the oldest observation towers in Albania.

The tower evolved over centuries, losing its original defensive function and gaining civic importance (Fig. 6). By the XVII century, it was adapted into a clock tower serving the local bazaar. Artists and travellers like Edward Lear (1848), Edith Durham, and Theodor Anton Ippen recorded its image and significance in their works. Architecturally, the tower is a type II clock tower (attached to another building) with two floors. It stands 15.75 to 17.2 metres tall, depending on terrain elevation. Its base is pyramidal, transitioning to a square-plan prismatic shape at the top, this upper part is probably a later

reconstruction using the pyramidal basement, with the upper room delimited by eight stone pillars bearing a wooden roof.



Fig. 2- The first siege of Krujë in a print by Jost Amman (1578), original and AI interpretations



Fig. 3- The first siege of Krujë in a print by Jost Amman (1587), original and AI interpretations



Fig. 4- map of the Kruja castle: 1. The watchtower. 2. The museum. 3. The Tekke. 4. The town historical market area. 5. The access road which was enlarged in the '80s. 6. Main perimeter of the walls. (Base from Google Earth©, 2025)

Built primarily of limestone with brick insertions, the walls have a variable thickness up to two meters. Two entrances (an unusual feature for towers) face southwest and northeast, probably realized in different times. The structure showcases three main construction phases. The earliest, evident on the northern side, features a mix of limestone and bricks from the XI century. A second phase, using the cloisonné/castone technique (Canali & Galati, 2022), dates to the XIII–XIV centuries.



Fig. 5- The watchtower in the context

The third is connected to the conversion into a clock tower. The clockwork for the clock in the tower of Krujë castle was crafted by artisans from the Old Bazaar of Krujë, it was used to manage city time, such as the opening and closing of shops and the times for prayer. One or more bells were used to signal the time passing.

Several historic bells are associated with the tower, used for alert signals and later for civil uses. One bronze bell from 1462, possibly used during Skanderbeg's campaigns, is now preserved at the Albanian National Museum.

4. The Ottoman centuries

After Skanderbeg's death in 1468, the League of Lezhë weakened, and the castle finally fell to the Ottomans the fifth September 1478 after the fourth siege. A quite bloodish ending according to the following chronicles, with very few survivors who paid for their safety and probably then escaped abroad. Turkish settlers took possession of the empty town, and the toponym was changed to Ak Hisar or Akçahisar (the white castle). From this date the castle started more than four centuries of Ottoman government. Until the XIX century Christians would have been forbidden, under penalty of death, to enter the town at night (Jireček, 1914).

The fortified area served as an Ottoman garrison for centuries. Some religious buildings still show their remains, like the Sultan Mehmed Fatih mosque, built before 1481, which can still be seen on the castle grounds and left parts of the original minaret. The site also contains the Dollma Tekke, a more recent building erected in the second half of the XVIII century as a Bektashi place of worship, which highlights the multi-layered history of the fortress.



Fig. 6- The castle and the watchtower seen from the Krujë town centre (Rainchill & Commons wiki, 2004)

The restructuring of the fortress into civil building was progressive in this period, for example, when a major earthquake in 1617 probably caused the fall of a part of the tower, this was rebuilt and modified for being used as a civic clock, completed with a first bell chamber supported by eight wooden columns and topped with a dome (Çoku, 2021).

This solution was later replaced by the present set of stone pillars and wooden roof. On the front of civil architectures from this period, the castle still hosts a well preserved XVIII century Ottoman-era house that belonged to the affluent Toptani family, offering a glimpse into the lifestyle and traditions of the region in that period, it was restored to become the National Ethnographic Museum in 1989.

5. The Hoxha's regime period

In the XX century, the castle became a symbol of Albanian national identity. The dictatorship, in search of supporting Nationalist ideas, promoted the cultural attention towards historical and traditional aspects, in this the figure of Skanderbeg played a key role (Hoxha, 1975). A role in need of being supported by proper and specific architectures adopting a common habit from the Communist regime of creating monumental elements using a language connected to traditional Albanian architectures and graphics (Islami et al., 2017).

A new museum, aimed to valorise the remains of the fortifications and to celebrate the figure of the national hero. The idea of the new museum came out first in 1967, but its design dates to 1978-1979 while the construction took four years to complete till November 1982 (Hoxha, 2012). In 1982, the National Skanderbeg Museum was standing within the remaining walls of the castle. The eclectic appearance simulates an historical building and recalls similar architectural behaviours of the Communist regime in those years (Islami, 2008). The new museum was designed by the architects Pranvera Hoxha, daughter of the dictator Enver Hoxha (Fagu & Nepravishta, 2022) and Pirro Vaso in a style reminiscent of medieval Albanian stone towers (Dedaj, 2013), and probably influenced by historical representations and by the Ottoman name in itself. The museum showcases artifacts and exhibits detailing his life and the battles fought to protect Albanian independence (Jaupaj, 2014). The identity of the new museum creates a specific effect, a sort of 'castle in the castle' as well defined by previous accurate interpretation of this architecture (Islami & Veizaj, 2018). While the courtyard of the museum was ongoing, it was noticed that the narrow streets bringing up to the fortress were not suitable for contemporary vehicles, so it was decided to carve a part of the peaks and cliffs and tracing a new road with direct access to the upper part of the fortification. This intervention caused some structural damages to the rocks supporting the main

tower. The choice of creating a new road was probably made to help the access to the inauguration to Enver Hoxha himself, at the time already troubled by physical difficulties. The damages to the cliff soon became very concerning, so in the years after the opening of the museum a series of consolidation works were done to contain the cracks and the movement of the stones. During the XX century there were several restoration activities operating also on the main tower and on the cliff. Albanian country suffers from periodic earthquakes and after the old one in 1617 and before the 2019, those in the XX century, in 1947, 1956, 1968 and 1979 all brought damages to the built heritage of the castle. The wooden roof and the colonnade of the tower were reconstructed during two major restoration campaigns, the first in 1967 and the second between 1979 and 1980. The 1967 intervention focused on the partial restoration of the timber roof and its pillars. At the same time, repairs were carried out on the internal wooden floors. The later restoration addressed also on the reconstruction of the upper section of the pillars. This was done largely for aesthetic consistency. The columns were rebuilt with a wider cross-section, expanded by 30 cm, and externally faced with rough conglomerate stone, locally known as *grac* (Tafa, 2022).

To improve the tower's stability a reinforced concrete framework was installed at the upper floor. This modern support system was concealed behind stone blocks to maintain the original appearance. Additionally, reinforced concrete was cast at the base of the pillars, forming a structural beam also hidden by masonry. These careful interventions combined traditional materials with modern techniques with the belief of preserving the tower's historical character while reinforcing its stability, thus the main shake in 2019 was coming to demonstrate how these interventions were not a healthy cure for the tower.

6. Earthquake 2019

On 26 November 2019, an earthquake struck the Albanian coast, with a seismic centre nearby Durres at 41.38° North and 19.45° East, with a main seismic hit at eighth Mercalli's scale. It was one of the strongest earthquakes that occurred in recent years in Albania (Freddi, 2021). The event caused 51 deaths in population and produced heavy damage. 111 cultural monuments and heritage sites were assessed in the affected regions. Out of these, 53 were deemed unsafe or temporarily closed due to serious risk.

Major landmarks such as the castles of Durrës, Krujë, and Prezë sustained considerable structural damage. The seismic event exerted a pronounced impact on the built environment of Durrës and adjacent settlements, while considerable structural damage was also observed extending into the Tirana region. In the aftermath of the earthquake a long series of small and sometimes intense shakes keep on manifesting for weeks after the main event. The impact on the Skanderbeg's castle in Krujë was well evident, some cracks in the main walls and in the nearby building appeared immediately, but most of all, part of masonry from the top part of the tower fell down, large cracks opened in the tower and in the vault of the Dollma Tekke. In the case of the tower, the previous intervention using concrete caused a hammer effect on masonry, intensifying the damage and the fall of blocks, leaving large holes from which the concrete work emerged. To help the built heritage recovery, the Albanian Ministry of Culture asked for help from the digital survey expert operating at the Catholic University in Tirana, which has a teaching agreement with the Dipartimento di Architettura at the University of Florence. This brought to the organization of a quick expedition to Krujë on 19 December 2019, with the intention of documenting the state of the castle after the seismic event and creating a proper base for supporting further interventions.

7. Digital Survey intervention

The digital survey operation was completely conducted by SfM/IM photogrammetry, mixing terrestrial and aerial shooting into a detailed and complete digital model. Before arriving in place, the operating unit was informed about the situation of the buildings and had a detailed view of the scenario from a video taken using a drone by the emergency units operating in the area. The situation was not looking good, the top part of the tower was heavily damaged, the main shake, very intense, caused the rapid horizontal movement of the concrete slab applied in the old restoration, it acted like a rigid element on the top of a more elastic structure, causing heavy stress on the old masonry and producing the opening of old and new cracks. The stones on which the tower stands were appearing even more concerning, with large cracks and the old bolts in the consolidation work showing their poor conditions and a visible lack in their function. The survey planning was made starting from the top of the tower, where one of

the first limits was the impossibility to access the inside because of fallen parts and effective risks for the operators. The seismic event indeed had a long series of assessment shakes, one with Mercalli's intensity 4.2 just on the day of survey, making even more concerning the operative conditions. Then the photogrammetric survey was operated from a certain distance, with a generous round turn of terrestrial shooting and a consistent campaign of drone shooting. The terrestrial shots were taken using a Nikon D850 with a 47.3 megapixel full-frame sensor and mounting a Nikkor 24-120mm F4 lens set at 35mm focal length, producing 637 pictures all around the tower and along the masonry works from the base and up to the top. The aerial photogrammetry was operated using an UAV Anafi with a 21Mp Sony 1/2.4" CMOS sensor and with a wide-angle f/2.4 ASPH lens, 35mm equivalent focal length: 23-69 mm (sensor set in photo shooting mode), 26-78mm (sensor set in video shooting mode) from the French manufacturing company Parrot, producing 808 pictures.

The photogrammetric survey was divided in three groups of operations, the first dedicated to the Tower and the second to the Tekke, the third was focused on the surrounding terrain in order to carefully document the entire rock ridge on which the tower stands, highlighting the cracks and detachments that are actually present. In this way, during the data calculation phase, it was possible to develop large environmental sections that documented the entire site. Due to strong geomagnetic interference at the site, which made it difficult to fly the drone, it was not possible to operate with planned flights in sequence. Instead, it was necessary to operate exclusively with a long series of manual flights. This resulted in a longer survey time, but also made it possible to get very close to the top of the tower in order to document in greater detail all the information needed for a comprehensive assessment of the state of the tower's damage. In fact, to partially compensate for the impossibility to access inside, the UAV unit was operated with specific attention on the top part of the tower, capturing even inner details and surfaces (Fig. 7).

The sequence of drone pictures counted at the end 809 shots. The two photogrammetric series were planned to obtain a generous overlapping between the last shots taken by the terrestrial session and the first shots taken using the drone,

so as to simplify the connection and continuity between the two series in the photogrammetric elaboration. A secondary, but very important sequence of shots was dedicated to the cliff, with a specific series of 160 pictures taken by the drone on the cliff, to document the general shape and the condition of the cracks.



Fig. 7- The top floor of the watchtower in the photogrammetry model taken by the drone

The further processing work was aimed at the creation of a full 3D model, operating all the classical steps in the Structure from Motion Image Matching procedures.

The work was done using Epic Games Reality Capture 1.0, feed with the whole set of 1606 pictures and producing a 744 million triangles polygonal surfaces, then simplified to 241,3 million triangles and to 15 million triangles and 1.5 million triangles for multimedia uses, the reduced versions were textured and exported in OBJ format, while the textured full model was used to produce high resolution ortho-pictures (each at about 475 megapixel overall resolution) of all the fronts and top view of the tower in two different versions, one with the tower and another with tower, near area and front of the cliff.

8. The tower towards a full recovery

The entire set of materials produced during the survey campaign, along with the post-processed products, was then packaged into a well-organized folder and delivered to the Albanian Ministry of Culture. The set of bases were perfectly usable for restoration planning and interventions. In the following months, the recovery of the area started, with a variety of difficulties, mostly caused by the situation of the tower, where the bad conditions of the cliff were threatening the stability of the tower which was in its damaged state and a risk of a possible worsening.



Fig. 8- Fronts of the watchtower and QR codes for accessing the full survey report in Zenodo.org (up) and the 3D model in Sketchfab.com (down), the graphic boards of the survey are available on zenodo.org at: <https://doi.org/10.5281/zenodo.17273478>, the 3D model of the watchtower is available on sketchfab.com at: <https://skfb.ly/pBPTr>

In other words, an intervention on the cliff was a potential risk on the tower while an intervention on the tower was risky because of the condition of the cliff.

The conservation works undertaken on the Tower within the project Safety Measures for the Clock Tower, Krujë were primarily aimed at structural stabilization and risk mitigation. Initially, hazardous elements with imminent risk of detachment were secured. The upper section of the tower, which presented a high probability of stone fall, was enclosed with a protective metallic mesh. The facades were subsequently reinforced through perimeter banding: wooden planks and rails were positioned along all four sides and corners, tied with high-resistance polyester straps with a load-bearing capacity of 10,000 kg. In areas where masonry collapse had occurred, the stitch-and-unpick/indenting techniques were used, allowing for selective dismantling and reassembly of deteriorated portions, thereby reducing vulnerability to further instability.

Additional safety measures included the erection of scaffolding and the installation of steel bracing systems. Steel plates and Ø16mm tension cables were mounted and progressively stressed to values of 10kN, 9kN, and 8kN from the base upwards. A digital structural monitoring system was integrated, consisting of sensors and electrical connections to record and assess the tower's ongoing performance. Internally, the masonry was consolidated with timber beams, struts, and buttresses.

Finally, restoration of the flooring was achieved through the replacement of fractured tiles and the integration of missing elements. These interventions combined emergency stabilization with preventive conservation, ensuring both the structural integrity and the safeguarding of the monument (Tafa, 2022). At the moment of the writing the courtyard of the tower is still ongoing.

9. Conclusions

Nowadays, the site of the castle is still a tourist destination, with a consistent presence of visitors from Albania and a certain number of foreign tourists. The fortified complex stands as an attractive and fascinating reminder of a specific moment from Albania's heroic past, evoking the robust grip of Skanderbeg's memory. In a country quickly moving in a fast urban renewal (Santus, 2024) the castle is also an extremely layered architecture and a remembering about the need of restoration and heritage care. For this, a clear digital documentation of this built patrimony is an important base for any kind of intervention, but once more it should be clear how fundamental is creating sharable, versatile and high-quality contents, available for professional uses, research, studies.

In the case of the watchtower in Krujë all the materials were delivered to the Ministry of Culture in Albania, to support any intervention and give an efficient report about the state of the building and its surrounding just three weeks after the damage.

The same materials have been shared online in case of request and now the main graphic boards are available on Zenodo.org with an associated specific DOI, while the simplified 3D model is available in the Sketchfab.com platform (Fig. 8). The development of a Master thesis dedicated to the study of the consolidation and preservation of the tower was an evident confirmation of the versatility of the produced materials and how a correct digitalization, even if not complete (the interiors were not accessible for safety reasons) can properly work in multidisciplinary activities contributing to the preservation and giving a proper base for studying and better understanding the specific value of the monument.

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