

# Non-destructive Techniques for the Knowledge and Conservation of Abbey-Castle at Santo Stefano, Monopoli (Bari).

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*Abstract* – In 2013, the University of Bari and the Center for Aerial Photography Laboratory Consortium in Bari, under the scientific direction of Angela Diceglie, launched an interdisciplinary study entitled “The Territorial Context and the Abbey-Castle of St. Stephen of Monopoli (BA): Knowledge, Conservation and Development, which aims to ensure the preservation and survival of the site while respecting its identity and uniqueness. The project is divided into a plan of awareness, conservation and development. Knowledge plan has been developing through a campaign of historical-documentary investigations, design and survey efforts, and non-invasive diagnostic tests as thermographic analysis and archaeological reconnaissance of the site. We are starting a new research with georadar so we can confirm data of church and the monumental complex.

The goals are that we were able to reconstructed major phases of occupation of the site since prehistoric period until modern age; so gaining more insight into the architectural, geometric-dimensional, historical-critical and material-construction aspects of the fortified remnant and the site.

## I. INTRODUCTION (A.DICEGLIE)

*The aim of this contribution is to illustrate a synthesis of the results obtained from global archeology investigations (non-destructive investigations) through which, in the case of the study under examination, it was possible to clarify some aspects of settlements, constructive constructions and degradation of the abbey castle of Santo Stefano. The good, located on the Traiana road 3 km SE of the coastal city of Monopoli and about 5 km from the archaeological site of Egnazia in the South of Puglia, is known to have been from 1086 to 1317 a Benedictine monasterium et hospitale and from 1317 to 1806 seat of the Knights Gerosimitans. When the Order of Malta terminates its jurisdiction, the Castle is purchased by private individuals, and today, after various happenings of property passages and constructive renovations, is the residence of the De Bellis family of Castellana Grotte. The research, aimed at the*

*restoration of the good, methodologically, firstly included an analytical phase that is a type of critical-cognitive, articulated in archaeological and archival historical, geometrical-dimensional and material-constructive knowledge. It was therefore supported by surveys of its own global archeology, such as archaeological knowledge of the area, site unrecognized reconnaissance and remote sensing (shot by low-helicopter in the nearby visible and infrared bandwagon, photo interpretation, thermographic surveys). Knowing and documenting every aspect of the good has been the primary goal to be able to*

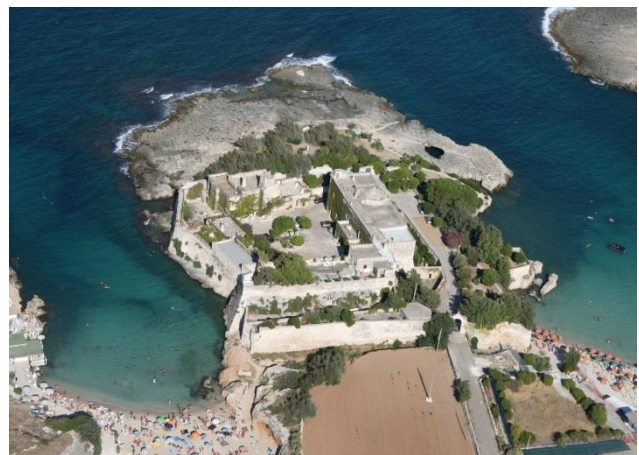


Fig. 1. Aerial view of abbey Castle of Santo Stefano LCA

## II. ARCHAEOLOGICAL KNOWLEDGE OF THE DEFENSE OF SANTO STEFANO (A.DICEGLIE, M.E.L.LORUSSO)

A first level of archaeological and comparative historical surveys was carried out on the anthropic landscape of the territory between Monopoli and Egnazia. The need arises from the hypothesis that the site of Santo Stefano has undergone a process of localization "similar" to that of





Fig. 3 Aerial view of Lama Santo Stefano



Fig.4 St. Stephen's feast plant (Valletta, National Library, AOM 6040, Cabreo of the Bishop of Santo Stefano) 1747-1748

### III. REMOTE SENSING SURVEYS (A.DICEGLIE)

Remote sensing surveys carried out by low-helicopter and ground (in the visible band and near infrared), in particular on the church artifact, provided data not available with other detection systems. Compared with the data from direct investigations, archaeological investigations and documentary historical records, they are contributing to the knowledge of the constructive phases of the castle of Santo Stefano.

A first helicopter photographic survey campaign was carried out in 2013 and allowed, given the strategic location of the artefact, to identify parts of the monument that were not accessible. The images provided a comprehensive view of the product, which compared with the data emerging from other studies have clarified some of the latest constructive events of Santo Stefano (covering systems, in the environment built between the 19th and early 20th centuries, different from the previous ones, types of wall weaving at different construction phases, the openings and blinds of doors and windows placed in places not fully accessible).

A second helicopter tracking campaign was carried out in February 2014 with the aim of obtaining information on the area of landslide sector B, no longer safe (see paragraph 1) [2].

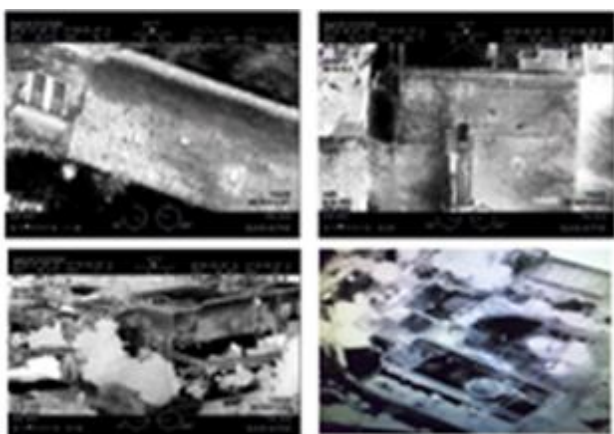
In May 2015, the first low-helicopter thermal detecting campaign was carried out with a State Police helicopter with a FLIR thermocamera [3]. This remarkable campaign has enabled us to confirm the data from the historical-documentary and remote sensing through the reading of the different thermal responses of the blocks of buildings seen from above. It was in fact known to us that in the eighteenth century, with the arrival at Santo Stefano del Balì Francone, the most significant restorations were made, which still determine the architectural configuration of the artefacts, which can be traced back to three executive moments: "August 22, 1757-23 September 1758 for the apartment and the works of external accommodation; 3 November 1759-16 February 1760 for the arrangement of the enterprise above the Portone del Ponte; from the first September 1760 to August 1761 for the continuation of the remaining factories of the outer courtyard walls, to keep the castle closed and guarded by the sea." Bali's intervention was thus a real restructuring project for the product, which was in an advanced state of degradation and disaster. Francone promoted a static consolidation of the Benedictine church through the construction of a "buttress", "... railing of lower and upper chambers ..." on N side, destined for a new residential apartment, since the oldest one, placed in E, was in a bad state of conservation [4]. The helicopter thermographic surveys confirmed that in the Block S (former Benedictine church and palace to inhabit Balì Francone) the wall texture corresponding to the roof plane has a different thermal response in the addition by Balì Francone in the 18th century, compared to that previous one. In addition, from these thermographs, it was possible to detect a series of thermal anomalies on the S facade of the church, related to its many refinements. In addition, in the courtyard the thermal discontinuities, indicated by the red circle of Fig., Have suggested that underground environments in opus reticulatum can continue even below the tread of the courtyard. [5]. The thermographic investigation of the manuscript compared with historical investigations and

archaeological investigations of architecture have documented, with different thermal responses, on the one hand the constructive events of the eighteenth century; on the other, the traces of the hidden wall structures-of which we do not yet know the length-visible to the naked eye in the basements below the church.

In addition, the thermographic investigation is helping to elaborate the thematic tables on the degradation of the structure of the building. The stone, used since antiquity for the execution of the structures, was subjected, from the extraction, probably local - as can be seen from aerial images documenting traces of ancient quarries on the rock - to a continuous degradation of the chemical type and physical. From here comes the different thermal response of the building materials, replaced, reused or sometimes of new and different extraction.

From the point of view of factory transformations, the period between 1808 and 1960 is certainly the most important one.

Through documentary research carried out in the archives of Apulia and Campania (State Archives of Bari (ASB), Ministry of Cultural Heritage, Bari Notarial Archive (ANDB), Ministry of Justice, Notary Archives of Naples (ANDN), Ministry of Justice) It emerged that in the period between 1845 and 1879 the church was altered in its original appearance, reduced to the two central modules. Nowadays research suggests that the church probably originally was characterized by three domes on the axis. In 1879 it is known that the East dome is embedded in the private home and the remaining two, different from the first one in their structure, remain in the ecclesiastical artifact.



*Fig.5 thermography to helicopter at low altitude in the infrared band near the prospectus S; prospect E; SO prospectus; church roof top and view of the inner courtyard*

In 2015, a thermal earth mapping is carried out to support the data from the helicopter thermographic survey (professional Testo 885 camera, resolution 320 x 240

pixels, with optional extension to 640 x 480 Pixel Super Resolution technology and thermal sensitivity <30 MK). From a methodological point of view, the external shoots were made using solar source while in the church interior sources of artificial heat. The two-dimensional maps of radiometric measurements, transformed by the acquisition system into spatial temperature distribution images (thermograms), affected the most superficial outer layers of the architectural wrap (the accuracy in the restoration of wall textures and discontinuities present is a function of the thickness, typology and integrity of the plaster, the properties of the masonry materials and the amount of thermal stress), with a maximum depth penetration range of between 3 and 4 cm. These images were subsequently processed with IRSoft software for analysis, processing and storage of images captured by the camera. It has an integrated protocol generation system for a clear graphical representation of the data. The shootings were made on the Benedictine portal (West), on the prospect of the former church of Santo Stefano protomartire (South), on the prospect of the palace to live in Francone (East). In this case, the heat source used was the sun. In fact, shots were taken at different times of the day, selecting those made before the dusk - at the time of so-called "thermal inversion" during which the masonry investigated, previously exposed to the natural warming of the sun, escapes from the thermal equilibrium phase in which all the materials have more or less the same temperature) and begin to cool by yielding heat - in order to be able to better detect possible disomogeneities present in the various materials that make up the above structures. The thermograms were then resumed in the thermal inversion phase in order to detect the discontinuous distribution of the surface temperature of the masonry, due to the different thermal behavior. In the I ° REPORT of the South Prospect it is possible to note from the thermal response of the wall studs that the points 1 and 2 correspond to the oldest part of the wall, while the points 3 and 4 are part of a more modern wall, perhaps corresponding to repairs carried out between 1845 and 1875. In conclusion, it is possible to assume that the western wall corresponding to the Benedictine portal at the top has been rebuilt with calcarenic material similar to that of the upper prospect of the south wall (where the chains introduced in the XIX century after the resizing of the church are located). Also always on the south wall, the thermal response of the bottom does not find comparisons with other points of the artifact. The thermal shots made inside the church showed other data below the subtle plaster state: wall textures of different typology; a walled monofora (visible also outside and without relation to the compositional aspects of the span in which it is inserted); an abnormality of the wall texture in the south, referring to a burial. In the I ° REPORT of the South Prospect it is possible to note from the thermal response of the wall studs that the points 1 and 2

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Fig. 6 Thermographic relief of a section of church wall S

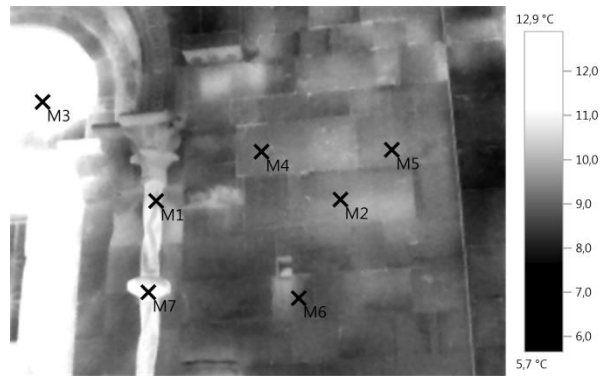


Fig.7 Thermographic relief of the Benedictine portal E

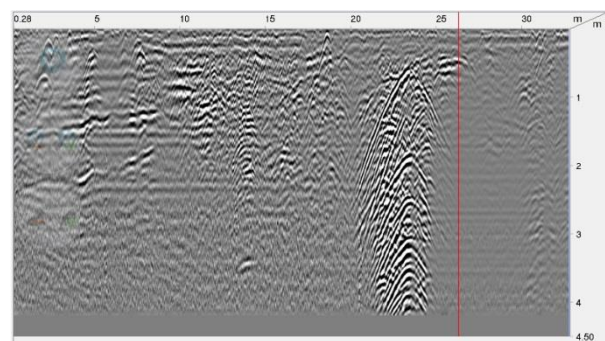


Fig.8 External georadar relief courtyard

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