

Integrated studies for the enhancement of complex historic monuments

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1. Foreword (R. Prescia)

The present study illustrates a research program based on specific disciplinary contributions on restoration and 3D laser scanning survey; its goal is put into evidence the values and the features of complex and monumental buildings whose layout is the result of historical stratifications.

The research is focused on two monuments belonging to the so-called “Arab-Norman” medieval architecture in Palermo; such monuments, in spite of their international relevance, haven’t been yet studied and protected in a proper way.

The studies on medieval architecture in Sicily, being not addressed to restoration, are not focused on materials and construction analysis, neither on the state of conservation of the monuments and their present use.

In order to optimize the cultural offer and the communication methods for different targets of audience in recent years several studies have been addressed to the use of innovative methods of storage and diffusion of heritage related knowledge¹.

Information technologies are today scarcely used for the documentation of medieval architecture and of cultural heritage in Sicily. Although Arab-Norman is a main feature of the character of Palermo, its documentation is not yet adequately supported by digital technologies².

Our goal is to create a database that can be used both to examine the monuments in depth and to create a Monitoring Plan as well as a specific Maintenance Program, in order to lay out a Planned Conservation process.

In order to achieve such goals the research has been extended to external sources (surveys, archives, studies, etc..) which are often difficult to find and often not linked to each other.

Several researches on the Arab-Norman architecture have been developed in recent years inside the Department of Architecture at the University of Palermo. Degree thesis, as well as workshops, seminars and conferences, have been focused on the monuments built in the XIIth century³.

The project aims at an innovative way of cataloguing architectural heritage through the inclusion of inedited collection of unpublished data related to the history of restorations, the identification of the features of constructive techniques and of decays, based on scientific surveys. The project aims to the development of a proposal for a multi-disciplinary indexing, and for data “networking” through the use of targeted communication strategies, able to attract as many users as possible. Proposed virtual paths are also intended as a proposal of real visiting tours.

Two case-studies sited in Palermo have been examined: the eastern end of the Cathedral and the Pisana Tower in the Royal Palace⁴.

2. The digital representation of historic monuments (F. Agnello)

The surveying project of the monuments has been structured in two steps:

- Metric data collection
- 3D Modelling

3D model and digital drawings have been produced with Rhinoceros 5.0; point clouds have been displayed inside Rhinoceros with the Pointools4Rhino plugin. 3D digital models are extremely flexible and can be used for different purposes in architectural documentation. When the purpose is the 3D analysis of the geometric features of structural decay (out of plumbs, bulges), the 3D model must properly fit the scanned data; Pointools allows checking in real time the punctual correspondence between modelled surfaces and point clouds. If the purpose of the study is the documentation of materials and of surface decay, high resolution digital images can be mapped onto the 3D model; decays are so properly positioned in their effective 3D location and the analysis on the causes of the decay can be related to the geometry and structure of the building. Finally, 3D models allow the 3D reconstruction of previous restorations, thus documenting the specific features and constructive techniques of each structural element.

3D models of the eastern end of the Cathedral and of the Pisana tower have been used to implement two different digital outputs: the first one is addressed to the implementation of an interactive database, the second one to interactive visualization.

The 3D model of the higher end of the eastern front of the Cathedral has been texturized with high resolution digital images and information data have been linked to it. Links have been focused on subjects that are particularly relevant for restoration and conservation, i.e. constructive materials and surface decays. The digital output allows an easy access to information data directly from the 3D model⁵. Decays are overlaid on the 3D texturized model and can be updated according to a specific schedule. This digital application has been tested on a specific area in order to setup classes and a hierarchic structure that can be used for the documentation of the whole monument (fig.1-2).

The 3D model of the Pisana tower has been converted in a pdf compatible format and has been inserted in an Acrobat file; inside Acrobat Reader the model can be explored and visualized with different shading options (fig.3-4); plane sections can be extracted and linear dimensions can be measured; geometric data can be structured with layers that can be displayed in real time; this way additional information on structural decay or on additions or modifications can be overlaid to the 3D model.

Decays are not still, but in permanent evolution; the tested application is an useful approach for the documentation of the state of conservation of the monument, but it does not match the needs of a permanent updating; the evolution of this research will be addressed to test the effectiveness of BIM software in the documentation addressed to restoration.

The tools for the visualization and information access developed in this study are an effective support for scholars and operators involved in maintenance and in restoration, but can as well be used for information and content delivering addressed to not trained users, i.e. tourists and art lovers.

2.1. The eastern end of the Cathedral of Palermo (S. Fiore Bettina)

The Norman Cathedral of the Palermo was deeply modified during the restoration work of 1781-1801 designed by Ferdinando Fuga and built under the supervision by G.V. Marvuglia and S. Attinelli⁶.

Laser scanning survey (fig.5) has allowed to graphically verify the reconstructive hypotheses developed by the historian Enrico Calandra, on the basis of the studies carried out by his disciple Antonio Zanca. Calandra assumes that the original Central apse was higher than the present one, with three stages of arches and reaching the height of the front of the so called antititolo (hypothesis a), or alternatively that it ended at a slightly lower height (hypothesis b) (fig.6).

Furthermore, the survey shows the present layout of the clerestory, whose remains are today restricted to the northern and southern ends of the eastern front (fig.7). Calandra assumes that the clerestory originally extended to all the walls of the antititolo and to the choir (fig.8); the comparison with the present structures of the Cathedral has been used to verify such assumption and propose a virtual reconstruction of the clerestory gallery (fig. 9)⁷.

Fig.1, 2 - Digital tool for the access to information data from the 3D texturized model

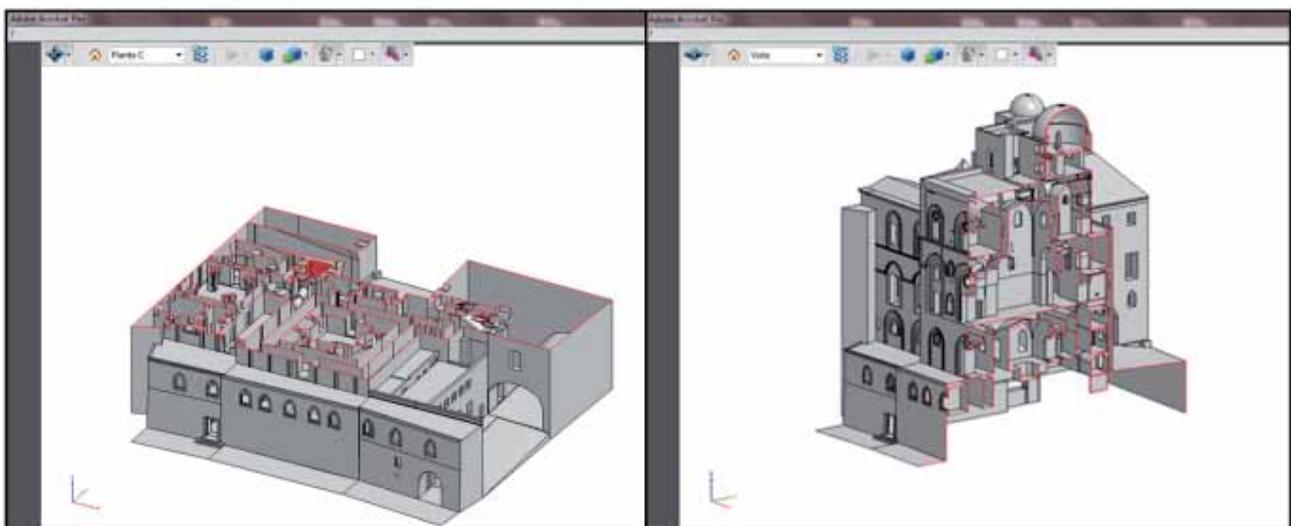
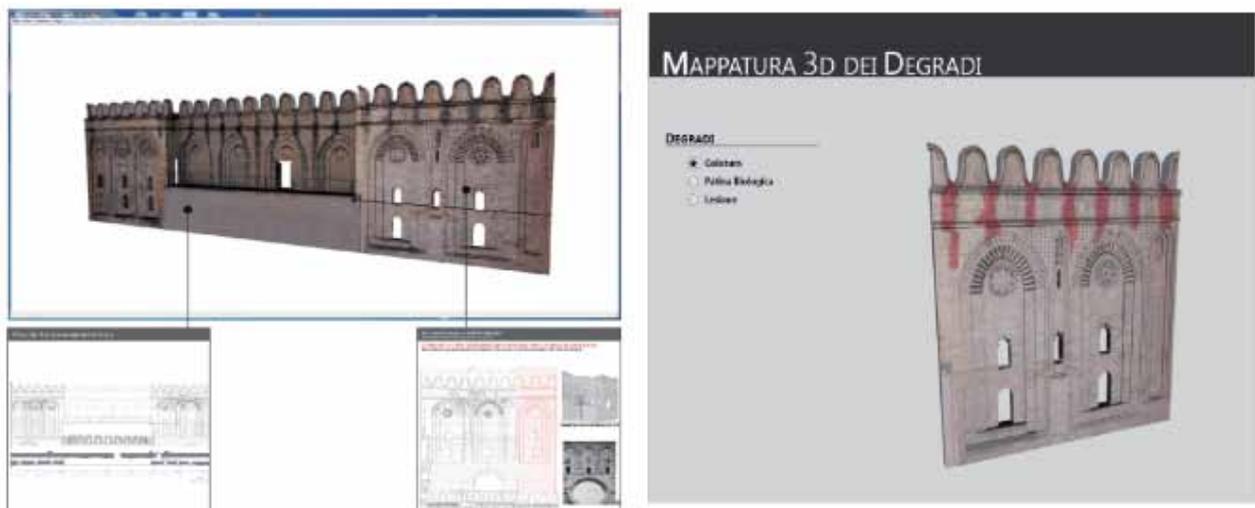


Fig.3,4 - Views of 3D model in Acrobat Reader: horizontal section and vertical section

The survey has allowed a punctual recognition of the areas restored in the '60s and in the '90s (fig.10)⁸. The accurate documentation of materials and of decays has revealed serious risks due to the defects in the system for the run-off of water from the roofs.

2.2. *The Pisana Tower in the Royal Palace of Palermo* (L. Lucchese)

In the XVIth and XVIIth century the Pisana tower was transformed as the residence of the vice-royal family and between 1829 and 1835 the Bourbon government allowed the building of an Astronomical Observatory over the roof

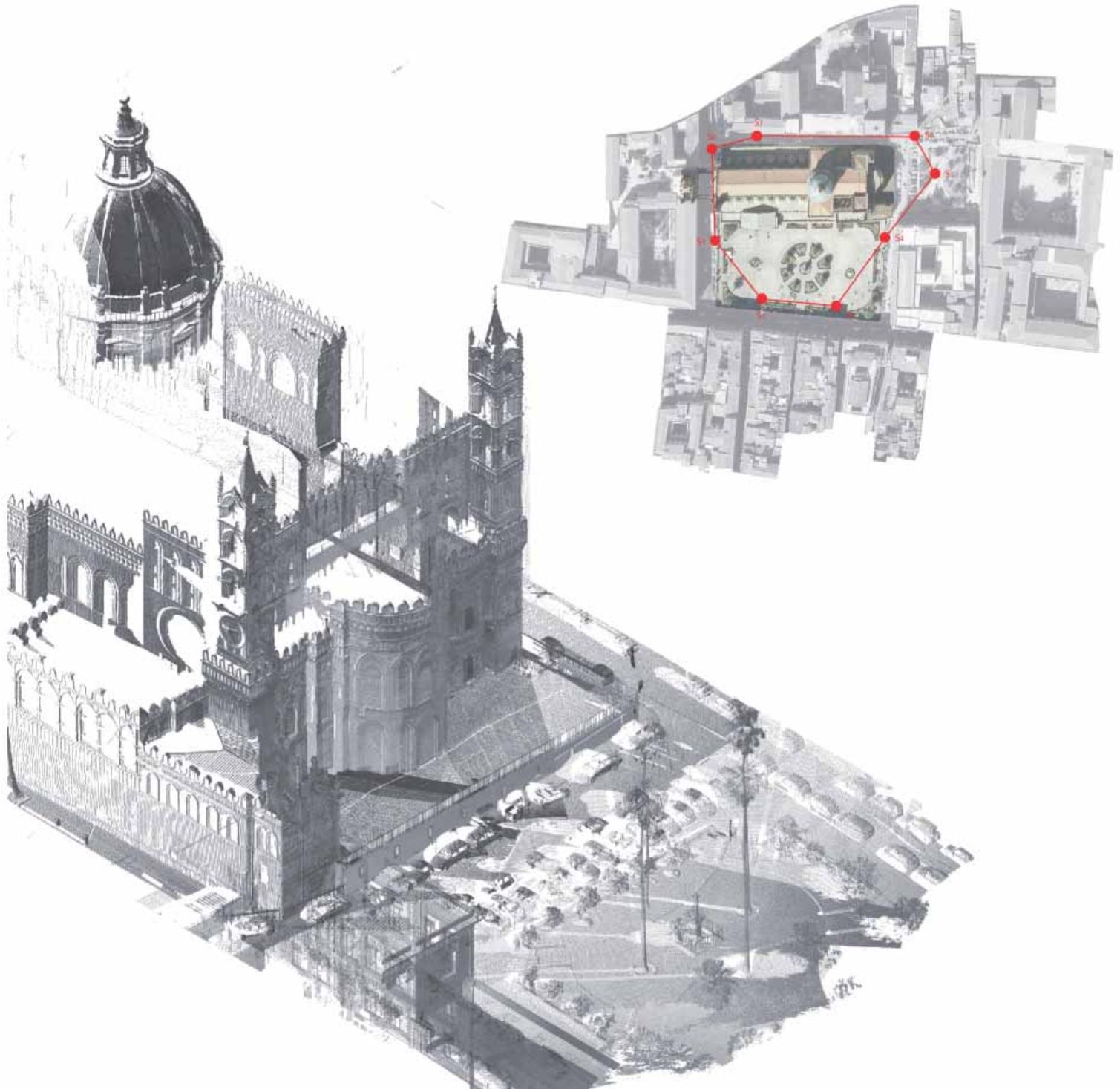


Fig.5 - Topographic polygonal (right above) and perspective view of the point cloud
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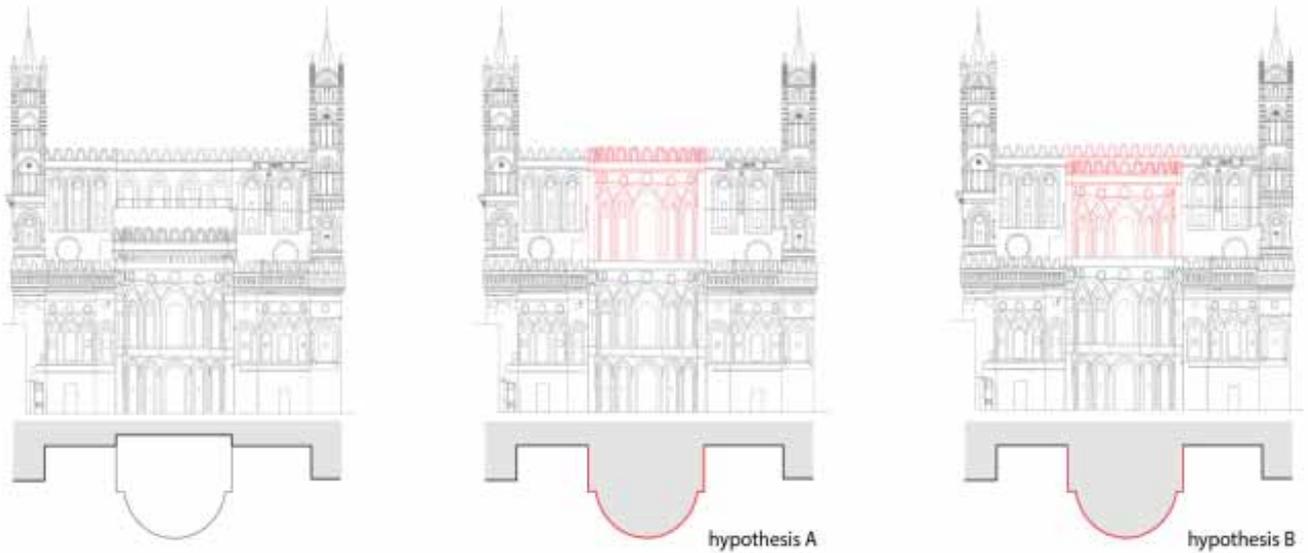


Fig.6 - Drawings of the eastern front of the Cathedral (reconstructive hypotheses highlighted in red)

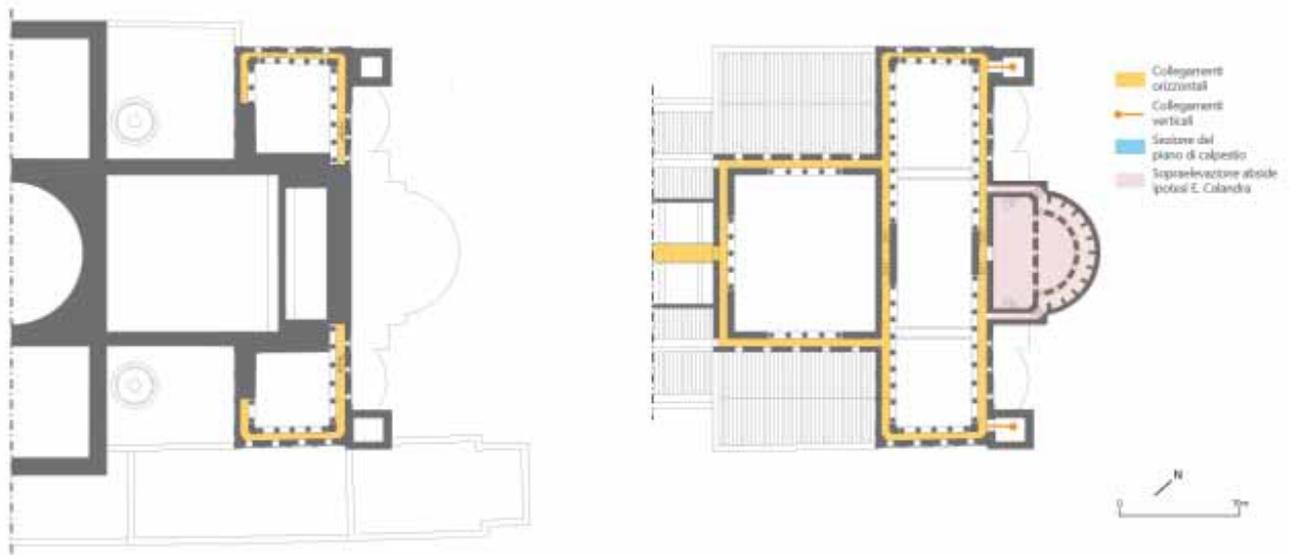


Fig.7 - Clerestory: plan of the present layout; Fig.8 - Clerestory: plan of the reconstructive hypothesis

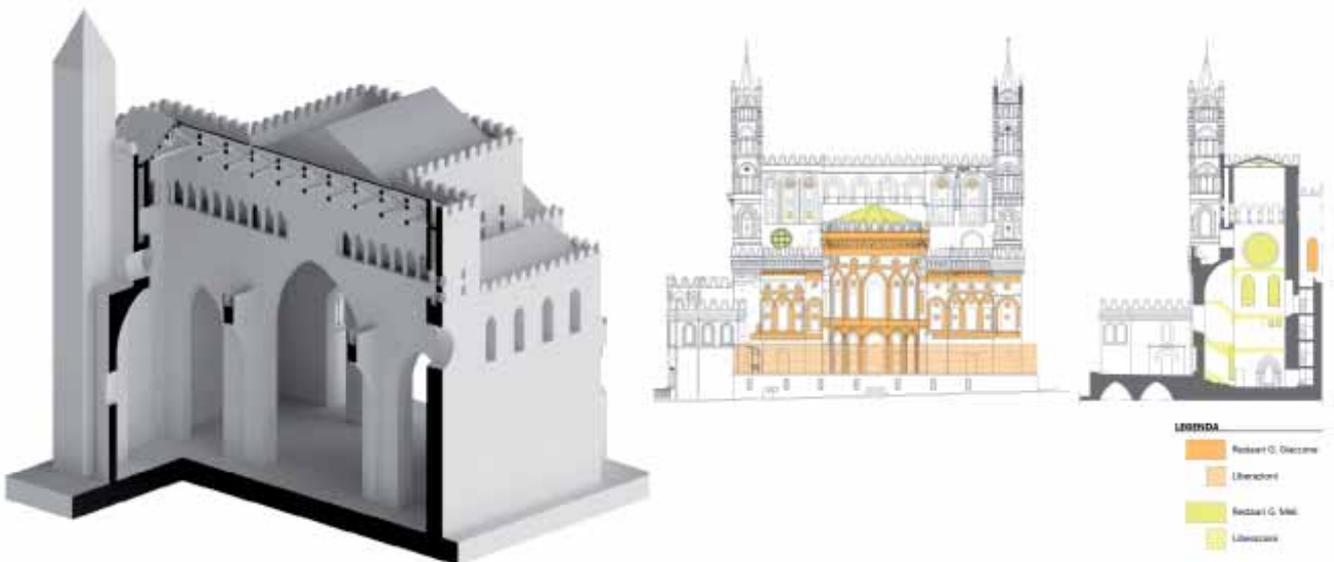


Fig.9 - Perspective view of the reconstructive model; Fig.10 - Front view and vertical section; restoration highlighted

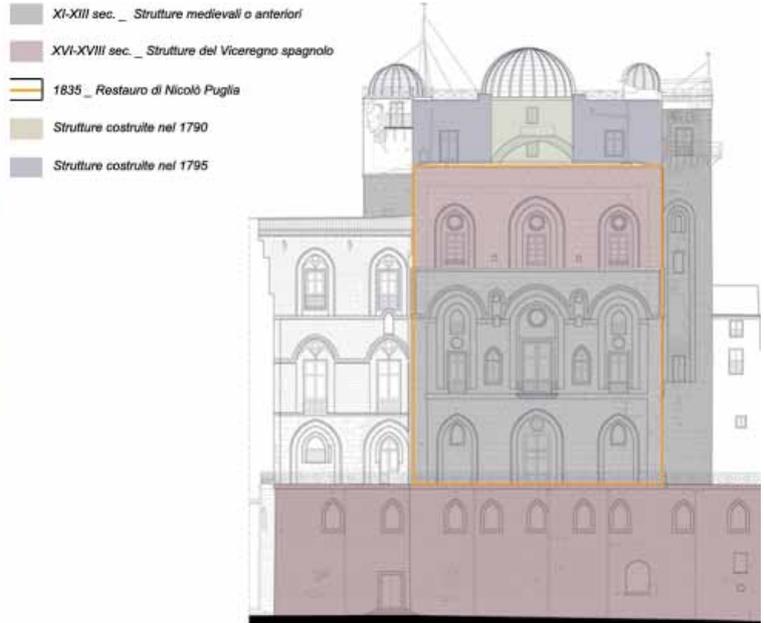


Fig.11 - Photo of the eastern front of *Pisana* tower; Fig.12 - Drawing of the eastern front: historic phases highlighted

of the ancient tower (fig.11). At the same time the external fronts of the tower were reshaped in a Norman style configuration, according to the retrospective attitudes of the architect Nicolò Puglia. In 1920 the tower was taken in charge by the Ministry of Education (fig.12) and a study of the tower, addressed to the detection of the original parts to be restored, is started. This intervention was carried out by the Superintendent architect Francesco Valenti who proposed the demolition of elements built after the XVth century so to put into evidence some rooms of the old tower, the “treasure room” (fig.13-14), the royal apartment (fig.15-16) and the apartment of the astronomer Gori. The inedited archival research has allowed us to precisely detect the interventions promoted by Valenti and to represent them inside the 3D model of the Tower.

In the SW corner of the Pisana tower, Valenti found an ‘ancient staircase’



Fig.13 - The “Treasure room” before the restoration; Fig.14 - The “Treasure room” today



Fig.15 - Vertical section of the the tower (M. Guiotto 1933); Fig.16 - Vertical section: restoration highlighted

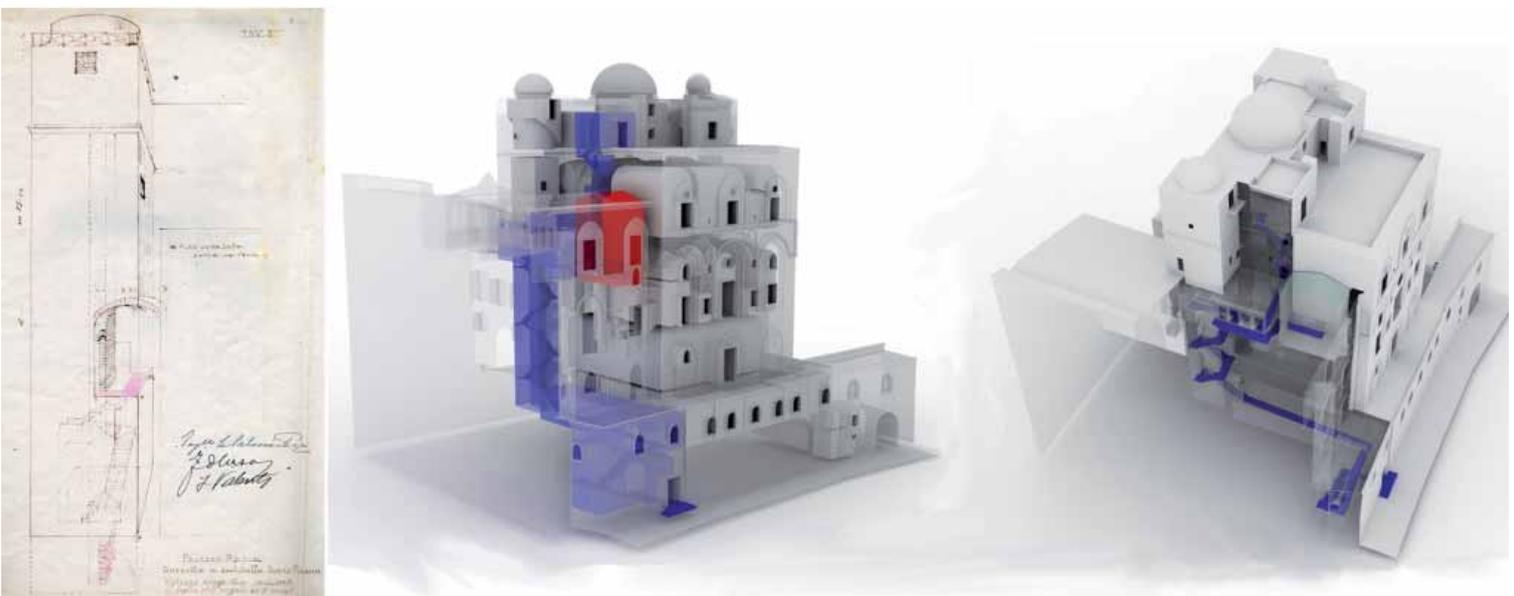


Fig.17 - Drawing of the ancient staircase (F. Valenti, 1921) and views of the 3D model (staircase and proposed paths highlighted in blue)

that he planned to re-use as a new access for the Astronomical Observatory (fig.17); at that time the access to the Observatory passed by two stairs built over the roof of the northern aisle of the Palatine Chapel that had caused serious decays to the underlying structures.

Valenti destroyed the stairs over the Palatine Chapel, but could not use the old stair case as he intended to; in the '60s two flights of the stair have been destroyed in order to place an elevator for the members of the Sicilian Regional Assembly (ARS).

In this study two independent accesses for the ARS members and for the Observatory have been proposed, according to the proposal of Valenti; despite Valenti, the proposed restoration cares for a clear distinction between the new intervention and the previous structures.

Notes

¹A. Negri, *Tecnologie informatiche per la conoscenza e la conservazione*, 63-99; C. Bartolomucci, *Nuovi metodi per la documentazione*, 105-140 in G. Carbonara, 2008, *Trattato di restauro architettonico - Il aggiornamento*, Torino; F. Romana Liserre e C. Bartolomucci, *Tecnologie per la conoscenza delle fabbriche*, in D. Fiorani, 2009, *Restauro e tecnologie in architettura*, Roma, 97-109.

²The Sicilian Regional Assembly (ARS) has recently commissioned a virtual Tour of the Royal Palace of Palermo, that is not based on an accurate historic survey of the palace; in a similar way further digital documentations of historic medieval monuments of Sicily are delivered via Cd-roms that do not allow any interaction between the digital documentation and the final user.

³R. Prescia, 2012, *Restauri a Palermo. Architettura e città come stratificazione*, ed. Kalòs, Palermo; R. Prescia, 2012, *Il complesso monumentale di Maredolce. Il "sollazzo" normanno alla ricerca di un nuovo paradiso*, «Kalòs», a. XXIV, lug-sett., n. 3, 18-22.

⁴L. Lucchese, *Torre Pisana nel Palazzo Reale di Palermo tra conoscenza e valorizzazione*; S. Fiore Bettina, *Le absidi della Cattedrale di Palermo tra rilievo, restauri e valorizzazione*, degree Thesis A.A. 2011-12, Tutors F. Agnello and R. Prescia, Faculty of Architecture, Palermo.

⁵3D Model is available at <http://www.redpoints.net/tesi/1/cattedrale.html>

⁶S. Boscarino, 1993, *La «restaurazione» della Cattedrale nel Settecento*, in L. Urbani, *La Cattedrale di Palermo: studi per l'VII centenario dalla fondazione*, Palermo, 93-103.

⁷A. Zanca, 1952, *La Cattedrale di Palermo dalle origini allo stato attuale*, Palermo; E. Calandra, 1942, *Il Duomo offamiliano di Palermo*; E. Calandra, 1941-2, *Lettera ad Antonio Zanca*, ms pubblicati in P. Barbera, M. Iannello (a cura di), *Enrico Calandra, 2010, Scritti di architettura*, Palermo, 215-247

⁸ Restorations in the years 1982-99 have been supervised by arch. Guido Meli (Ass.to Reg.le BB.CC.AA.) G.Meli, *Il restauro della Cattedrale di Palermo*, in A. M. Romanini e A. Cadei (editors), 1994, *L'architettura medievale in Sicilia: la Cattedrale di Palermo*, Palermo, 43-96; G. Meli, *Il tempio restaurato*, in G. Villari, G. Meli, 2001, *Il tempio dei re*, Palermo, 51-90.