UNIVERSITY OF NAPLES "FEDERICO II"

PHD IN SEISMIC RISK

XXVII CYCLE

INTERDISCIPLINARY APPROACH TO THE CONSERVATION OF CULTURAL HERITAGE IN SEISMIC AREAS

Tutor: **Prof. Ing. Giovanni FABBROCINO**

Co-Tutor: **Ing. Domenico BRIGANTE**

Coordinator: **Prof. Aldo ZOLLO**

Candidate: **Arch. Adriana MARRA**

Acknowledgements

At the conclusion of this experience I wish to thank all the people who have contributed to the realization of this work.
I express my gratitude to Prof. Giovanni Fabbrocino for the trust, for what he transmitted to me, and because he allowed me to do and accomplish this experience.
Thanks to Prof. Massimiliano Savorra for his precious support and help.
My heartfelt thanks to my co-tutor Eng. Domenico Brigante, and all Brigante Engineering Ltd., for the support they gave me in this long journey, for the opportunities they offered me and for the experiences shared together.

I thank the Coordinator of the PhD, Prof. Aldo Zollo, and all the College of Teachers, for their patience and understanding shown towards me.

I thank Guido Celentano for its availability, presence and understanding, but above all for putting up with me in recent years.

I thank my "new friends", especially Ivana, Francesco and Alessio, without them this experience would not have been the same.

Last but not least, the most important "thank you" goes to my family, who supported me with love and patience every day of my life. I do not thank you enough.

Part of the research activity was performed within the framework of the MiBAC-ARCUS "Analysis of the seismic vulnerability of the state museums" research project, a

special thank is due to Arch. Stefano D'Amico, Arch. Pia Pietrangeli and Arch. Anna Ciavardini.

Index

Introduction

The preservation of the cultural heritage is a complex process not only because of the intrinsic characteristics of the historical buildings, but also for the simultaneous presence of real interest from the point of view of art, such as furniture and decorative elements as works like stucco, frescoes. A similar task was much more difficult in an area like the Italian one exposed to considerable natural hazards including earthquakes. With the aim to support proper preventive actions and mitigation of seismic risk, in recent times the regulatory framework has been heavily renovated.

In this context it is essential the knowledge of the main formal, structural, functional characteristics of the protected works and to extend this knowledge to movable also in seismic perspective. Such an objective could be pursued through simple and rapid tools, able to characterize the object in a simple and standardized way, thus providing a hierarchical structure of information that define it and provide the essence, appreciating the quality and highlighting the criticality under exceptional actions.

The aim of this thesis is to discuss and extend the approach to the structural and non-structural knowledge outlined in the "Guidelines for the evaluation and reduction of seismic risk of cultural heritage", to the movable heritage.

After a brief definition of the seismic risk and the concept of cultural heritage, in the first chapter it is given a summary of the methodologies currently available in the context of seismic vulnerability assessment of the protected heritage and a classification of the museum typologies that can be detected.

The second chapter provides an overview on the different methodological approaches that have led to a differentiation on the contents of the terms conservation and preservation, while seeking to emphasize the contribution that the history and new technologies have provided in this wide field.

The third chapter traces the path of knowledge drawn in the Guidelines highlighting the importance that it assumes in the context of the seismic vulnerability assessment.

The fourth chapter, starting with the general principles and standards defined in the Guidelines on Artistic Limit State, analyses their state of art. Moreover, it highlighted the need for an adequate protection strategy of movable heritage starting from the

analysis both of the different typologies of artworks exposed in museums and their behaviour in the case of an earthquake.

In the fifth chapter it is discussed a new and speedy survey protocol for the preservation and knowledge of movable heritage in seismic zone. It also illustrates the results of the investigation plan conducted on the case studies of the Museum Complex of Santa Chiara in Naples and the Monastic Complex of Trisulti in Collepardo, of which more details are given in Appendix.

The sixth chapter focuses on the problem of preservation and conservation in the early stages of structural assessment from the application of methods of non-destructive test on buildings. In this chapter it highlights the role of the investigation plan in relation to the knowledge for the restoration and to the knowledge for structural assessment, defining their sustainability as a function of the level of assessment that is to be reached.

1. Architectural and museum heritage

1.1. Introduction. The seismic risk

The risk is defined for a territory or a population of objects, buildings, goods and people on the basis of expected damage as a result of possible natural or anthropic origin events [1]. Generally, locate the seismic risk in a specific point means to define the average frequency and the destructive potential of earthquakes felt in an area, which is to identify the probability of damage in an area. If the damage due to seismic activity in a time interval (t_1, t_2) is expressed by $d\ (t_1, t_2)$, random variable because deterministically unpredictable, the risk is identified with the probability distribution $P_d[d; t_1; t_2] = Pr\{\underline{d}(t_1; t_2) \leq d\}$, that is the probability that $\underline{d}$ does not exceed a certain predetermined value d in the interval time from t_1 to t_2. It's clear that the damage depends parametrically by the instants t_1 and t_2 which delimit the interval time that you want to observe [2].

The extent of the damage expected and, therefore, the risk depends on three factors, linked to the nature, frequency and level of expected events; to the nature, quality and quantity of exposed goods; to the ability of goods to resist insults.

The process of seismic risk assessment can therefore be expressed by a nonlinear function, combination of the variables H (Hazard), V (vulnerability), E (exposure), according to the expression $R = f(H, V, E)$.

The seismic hazard (H) is represented by the frequency and strength of earthquakes that interest it, or from the seismicity. It is defined as *the probability that in a given area and in a certain time interval occurring a seismic event that exceeds a threshold of intensity, magnitude or peak accelerations (PGA) capable of causing damage* [1]. Since it is impossible to predict earthquakes or interfere with the frequency or intensity of these, the hazard of a site is identified by the quantification of reference actions in each area, with the definition of appropriate seismic hazard maps.

To define the parameters suitable for the quantification of the hazard, different methodologies are used. These are based on different sizes; in fact, the hazard can be defined in terms of macro seismic intensity or peak ground acceleration (Peak Ground Acceleration - PGA) and spectral acceleration.

The macro seismic intensity is an established and dimensionless characteristic that describes the destructive potential of the earthquake on the base of observation of effects and of any damage, caused by quake. The main scales of macro seismic intensity are the Modified Mercalli (MMI) of 1931, the Medvedev - Sponheuer - Karnik (MSK) of 1964, and the European Macro seismic Scale (EMS 98) of 1998, which provide different macro seismic degrees directly related to the level of damage observed following a seismic event.

The mechanical representation of the seismic input is given by the PGA and spectral acceleration. The PGA is the maximum value of the ground acceleration reached during the reference event and, based on this, it was possible to draw up maps representative of seismic hazard area and which can be understood as possible "*seismic scenarios*" [3].

The term seismic exposure (E) refers to *the extension, the quantity, the quality of the different human elements that compose the territorial reality (population, buildings, infrastructure systems, etc.) whose condition and performance may be damaged, altered or destroyed by an earthquake* [1]. In the assessment of seismic risk, the study of the seismic exposure serves to reveal the amount and extent of all human elements at risk that may be subject to damage as a result of the earthquake. The main risk categories to be examined in the analysis of exposure are people, artefacts and property [3].

The seismic vulnerability (V) is defined as *the propensity of people, objects, activities or goods to suffer damage or changes as a result of an earthquake* [1]: such damage can induce a temporary loss or reduction of functionality of artefacts and structures or even a total loss. However it is possible to reduce the expected damage by improving the structural and non-structural features of artefacts through interventions.

1.2. The assessment of the seismic vulnerability

As stated in the previous paragraph, the seismic vulnerability is defined as *the propensity of people, objects, activities or goods to suffer damage or changes as a result of an earthquake*. In relation to the capacity of resistance to seismic actions of the same elements it can be asserted that each system has its own vulnerability. So on the one hand the vulnerability measures the loss or reduction of the system efficiency to the

occurrence of a seismic event, on the other it measures the remaining capacity of the same system to perform and ensure the functions that normally carries up to speed.

The concept of seismic vulnerability is extremely complex and articulated differently depending on the object which it is applied, since the loss of functionality of a single artefact causes a propagation of the damage so extensive as many elements are functionally connected with the element damaged. Therefore it is useful to distinguish the following components: *direct vulnerability* (V_1), *induced vulnerability* (V_2), *deferred vulnerability* (V_3), in other words: $V = (V_1, V_2, V_3)$.

The *direct vulnerability* (V_1) is defined in relation to the propensity of a single element, simple or complex, to be damaged or collapse following an earthquake.

The *induced vulnerability* (V_2) is defined in relation to the effects of the crisis of the organization of the territory caused by the collapse of a simple element to the subsystem to which it belongs; or from one subsystem to another functionally contiguous to it.

The *deferred vulnerability* (V_3) is defined in relation to the effects that occur at a later time of the seismic event that change, or overturn, the habits and behaviour of populations.

Therefore, in view of a comprehensive analysis of vulnerability, there is the problem not only of identifying single elements that can collapse under the impact of the earthquake, but it is also important to identify and quantify the effects that their collapse determines on the territorial system functioning (3).

Perform an analysis of seismic vulnerability means evaluating the consistency of the built environment in a given area, both in terms of quantity and quality, and in particular to estimate its propensity to be damaged by an earthquake. A methodology for the analysis of vulnerability must specify how to take a census of the built environment and its characteristics and develop appropriate models that correlate the severity of seismic motion with the effects in terms of physical damage and economic and intangible losses.

1.3.Methodologies and levels of vulnerability analysis

The vulnerability analysis on the ordinary territorial scale built environment involves evaluations on a large number of samples. So, the use of models of structural

calculation is unlikely both for the difficulty of identifying simple but reliable patterns, and for the amount of data that should be detected on field. Therefore, methods must be based on a few and empirical parameters and their validation depends on the observation of the damage caused by real earthquakes.

The vulnerability models depend on the characteristics of the building (typology, material, size, shape and construction details) and may be in different degrees of accuracy, depending on the level of knowledge of the elements investigated.

The methods are distinguished by the accuracy and significance of the data collected and catalogued according to three levels:

- Level 0: low degree of information of the collected data, which are described by the inventory of buildings without specific data, with the exception of the typology (at this level the vulnerability analysis is useful for a preliminary understanding of the seismic risk of a region or of a big city);
- Level 1: collection, by means of a fast survey, of some additional information with respect to the only typological identification and, in particular, of those data that can be related to the structural behaviour of the building (regularity, quality of materials, dimensions, interaction with adjacent buildings, state of maintenance, transformations and interventions);
- Level 2: targeted investigations and surveys that allow the collection of detailed information on individual artefacts and observation of detail of the damage. The overall vulnerability of individual structures may be defined.

The framework of analysis methods of vulnerability is very complex, so different classifications have been proposed [4].

A first classification is set on the type of result, distinguishing between:

- direct techniques: providing in one step the result as a prediction of seismic damage;
- indirect techniques: they first involve the determination of a vulnerability index *(V)* and subsequently use a correlation severity-damage which is also a function of the vulnerability index;
- conventional techniques: the result is an indicator of vulnerability, but it is not associated to it a prediction of damage. These techniques are useful for comparing

different buildings located in areas of equal seismicity.

A second classification is based on the type of measurement that is used, therefore one has:

- quantitative methods: are the most common and provide the result (damage) in numerical, probabilistic or deterministic form;
- qualitative methods: they are based on descriptions of vulnerabilities with terms such as "low," "medium," high "and the like.

A third classification is based on the predominant source of knowledge; it comes to techniques based on:

- the statistical processing of data;
- the calculation of seismic response;
- the subjective judgment of experts;
- hybrids procedures, which combine multiple sources.

A further classification concerns the manner in which the building is considered; distinguishes between:

- *typological techniques* take the possibility to differentiate the seismic behaviour (vulnerability) of buildings by defining a typological classification, according to the quality of materials, features and construction techniques or other factors. Each class is associated with a vulnerability curve or a probability matrix of damage. The verification of the assumptions made in the construction of the vulnerability curves or matrices of damage is entrusted to statistical processing of the damage caused by earthquakes in the past to the buildings of that class (a posteriori analysis).In this way, assigning a building to a certain class, it automatically confers the curve of vulnerability or the probability matrix of damage that compete to the class. These methods require rather simple field surveys, and can be used to get information about extended urban areas;
- *mechanistic techniques* are those which resort to modelling as realistic as possible of the seismic behaviour of buildings. The predictions of damage are formulated on the basis of analytical calculations of the seismic response of the building and on the stress and strain that corresponds to them. Their reliability is the common one for structural analysis applied to existing buildings, new and ancient. These

methods are suitable for evaluations involving individual buildings or very similar groups, and it can be of some help to other techniques, both on individual buildings to transfer the results for typological classes, and for better validate the vulnerability levels conferred through behavioural parameters;

- *semiotic techniques* are based on the ability to give each building an index of vulnerability that is a number, which is determined on the basis of indicators no longer interpreted with typological meaning, but behavioural, that is determined by the capacity of the building to withstand earthquakes (for example, the efficiency of the connections, the strength of materials). In a second time at each value of the vulnerability index is associated a vulnerability curve or a probability matrix of damage. Normally the vulnerability index is calculated as a function of partial indexes corresponding to each indicator and that can be conferred subsequently to qualitative assessment of the building. These techniques are very versatile, because they synthesize a large number of information on buildings that are examined. They imply a subjective judgment of experts and their reliability depends on the clarification of a relationship between the levels and the expected seismic damage.

Nationwide shared methodologies are not available, although different studies have been made in the past, starting from the vulnerability observed on a large number of buildings damaged by earthquakes.

1.4.Cultural heritage

The definition of *cultural heritage* - as a material product of the human culture, as opposed to the natural good offered by nature [5]- is the culmination of a long path. The concept of heritage is born and is measured by the discipline of restoration, constituting the object of his debate and its *praxis*, starting from the French Revolution and as a reaction to the abbé Gregoire's vandalism [6].

The evolution of the culture of the restoration is based on the collective dimension of the heritage [6]. The coincidence between the origin of awareness of the heritage and instances of conservation of monuments is extremely significant because the heritage is something that for its cultural value must be protected and must be shared with the

community. As reported by Aveta [6] the new vision of heritage *"is to intersect with the notion that the heritage has an economic charge, in fact, the same term heritage contains in itself those meanings and the value that can be found in similar terms as legacy, good, resource, etc.. The diversification of meaning is taken as a result of the adjective accompanying the term: so we can speak of cultural heritage in its historical and artistic meaning"*. However, the cultural heritage loses its economic sense when at this is recognized an additional factor that characterizes the peculiarities of the *cultural property*, lies in the awareness and in the feeling of belonging to the community.

It is well known that, the cultural heritage is representative of something that has come before us and for this reason the concept is closely related with the term *memory*. From this comes the desire to conservation based on the acknowledgment of the value of the goods, or rather this desire comes from the encounter between the individual and the collective dimension, from the recognition of something that is the testimony of memory sharing [6].

In this framework, the contribution of Riegl highlights the significance of the presence of the documents of the past in relation to the requests socio-anthropological: "*Monuments* - warns Alois Riegl- *seduce us as testimony to the fact that the collective of which we form a part long before of us has lived and produced*".

But the concept of heritage as a shared wealth and to share was already present in the thought of John Ruskin and William Morris, who had identified the profoundly social dimension of the monuments. For this reason, their conservation represented "*a moment of apperception of the signs of their own memory*" as collective and therefore linked to the recognition of the passing of time [6].

Considering the various documents, such as Chats of Restoration and European Recommendations, that took place during the twentieth century reveals, at first, the expansion of the field corresponding to the concept of heritage. At movable heritage was added heritage formed by buildings, sites, territory and the environment. However, it certainly depends by the changed perception of history and to the change of attitude by man against material evidences.

The definition of world heritage, which still refers, was established by the Paris Convention of 1972 and, more precisely, by the "*Convention concernant la protection du*

patrimoine mondial, culturel et naturel", adopted by the General Conference of UNESCO [6]. With this Convention we refers to a unique heritage, both cultural and natural, to which belong, in addition to typically cultural and natural goods, also the mixed goods, that are examples of a mutual adaptation, in the merger of the two types of elements. This represents our cultural heritage and it guarantees the persistence of *historical memory* belonging to every individual and common to all. With this Convention the universal value of some goods generated by the individual cultures and/or by nature is recognized. "*The aim is not to preserve local cultures and expressions as such, but as part of a heterogeneous mosaic that in its complexity is representative of the many and various achievements that wherever the mediation between man and environment has configured*" [6].

From the analysis of the Charts of Restoration and the European Recommendations *sectoralisation* heritage (something archaeological, artistic, church, etc.) arise [7]. Another important factor is related to correspondence to the need to safeguard and protect local identities. These two factors are interrelated, since the second appears to be the motivation of the first: that is to say that pushes and simultaneously explains the drafting of documents and resolutions concerning the configuration of the heritage as a set of elements traditionally *not artistic*, but more generally cultural, such as traditions, languages, crafts, and so on.

It is therefore difficult to give a notion of *cultural heritage* pertinent to what appear to be the needs of the community in relation to its wealth, both material and immaterial. However, a valid definition can be found in the document proposed by the Italian Committee ICOMOS in 1991 that identifies the *cultural goods*, and the cultural heritage, as all the monuments and things that are *testimony having the force of civilization* and that, as such, must be protected and valued.

1.5.Museum goods: definition, features and types

The term "museum" identifies the place where it is possible to collect and preserve evidence (artistic, historical, cultural, scientific) and expose them to the public and academics in order to increase knowledge of the nature and work of man [8].

The main features of a museum are safeguarding and/or preserving the documents of culture, promote access and consultation of this "heritage" to a growing number of users and ensure the cataloguing of materials and information collected [9].

In the museum are included aspects that can be defined more strictly "static", related to the field of cultural heritage, which go to weld together with "dynamic" elements of the reorganization of the matter. A museum, according to the definition established by ICOM (*International Council of Museums*)[1] [10] appears to be: *"a permanent institution, non-profit, at the service of society and of its development. It is open to the public and conducts research concerning the tangible and intangible evidence of people and their environment; acquires, conserves, communicates and, above all, the exhibits, for purposes of study, education and enjoyment"* [11](Seoul 2004) and must be able to implement all the specific functions related to the management of cultural heritage, which have been identified in the protection, or activity responsible for the conservation and preservation of cultural heritage; management, as an activity responsible for ensuring the use of cultural heritage, through the disposal of human and material resources; enhancement, as assets intended for optimizing the conditions of knowledge and conservation by increasing the use; the promotion responsible to stimulate and support cultural activities [12]. In the definition proposed by ICOM is highlighted the importance acquired by the scientific research inside the same organizational structure and emphasized the purely cultural purpose of the museum, as a place dedicated to perpetuate the cultural memory of a civilization in terms of testimonials tangible and intangible belonging to man and the environment in which he lives, this is the one that comes closest to the definition of Italian museums.

In Italy, the museums were poorly regulated institutions, for this reason it was necessary to define, through the DM May 10, 2001 *"Guideline on technical and scientific criteria and standards of functioning and development of museums"* [13], the statutes and regulations that defined the set of rules related to the specific function to be performed.

[1]The *International Council of Museums* – ICOM was created in 1946 in order to make known and protect the world's cultural heritage through the improvement of the same organization and the development of museums, entity specifically responsible for the activity of preservation and dissemination of past history of every civilization, as well as to act for the advancement of the museum itself.

The statutes and regulations constitute the reference point for the organization and operation of each museum and the tool to steer their activities, by defining the purpose and functions, tasks and activities, rights and duties, sorting and financial structure, organization internal and human resources, as well as the principles and rules for administrative and especially capital, management and care of collections and service delivery to the public.

The museums on the national territory are entities that, despite the structural and dimensional features very different from each other, providing a joint service of cultural nature.

The quality of the museum institute is not determined by reference to its level of merit, to the collections held, to the attraction on the public, to the physical dimension, but in relation to the ability to provide the service that is its purpose, and its ability to meet the specific needs of museum management, care of collections and services to the public.

In line with this methodological approach, the museum complexes are required to ensure that the structures that characterize them are appropriate to the functions which they are engaged, in accordance with the objectives of educational and cultural promotion and with reference to the needs of the collections, staff and public [8].

For this purpose, the museum must make explicit the requirements to which intends to follow, detailing those regarding exposure, conservation in time, registration, documentation and restoration of the collections, as well as services for the public in terms of knowledge, education, research and study and those for staff involved in the continued operation of museum structures.

In addition, the museum must ensure the availability of adequate structures both in typological and dimensional terms; they must therefore be characterized by:

- *flexibility,* or be able to adapt in relation to changing requirements;
- *Easy to equip,* have the capacity to satisfying different needs;
- *functionality*, be suitable to ensure the achievement of the objectives.

These museum structures should be also *controllable* (with modular performance in relation to the actual needs), *maintainable* (such that they can be kept efficient in time), *accessible and recognizable*.

The classical model of the museum [14] is specified then in the articulation of two functional cores aimed at these essential activities:

- *spaces for custody* (reserve) *of evidences* (artworks, archaeological, artworks of technique, products the so-called "material culture", etc.);
- *spaces for the exhibition of artworks*.

However this first and simple characterization is not sufficient to completely delineate what the museum typologies are on the Italian territory, so it is necessary to refer to some simple criteria, which often are intertwined in the definition of the role and institutional purpose.

With reference to the *dimensional parameter* [14] they can be distinguished:

- *small museums to local character* (works by local artists, museums of folk traditions, school science museums);
- *museums of average size* (of large municipalities, of school buildings, of university, of research institutions);
- *large museums* (of cities, archaeological, large research institutions);
- *national museums,* with the role of distribution and dissemination of information and artworks also to other structures of the national territory.

Based on the *criterion of specificity of the user* [14] - privileged recipient of the information - can be distinguished (Figure 1.1)

- *art museums* (art gallery, intaglio, cabinet prints etc.);
- *archaeological museums*;
- *science museums* (thematic, of foundations, of research institutes and universities);
- *museum of Popular Tradition or of "material culture"*;
- *museums of the costume*.

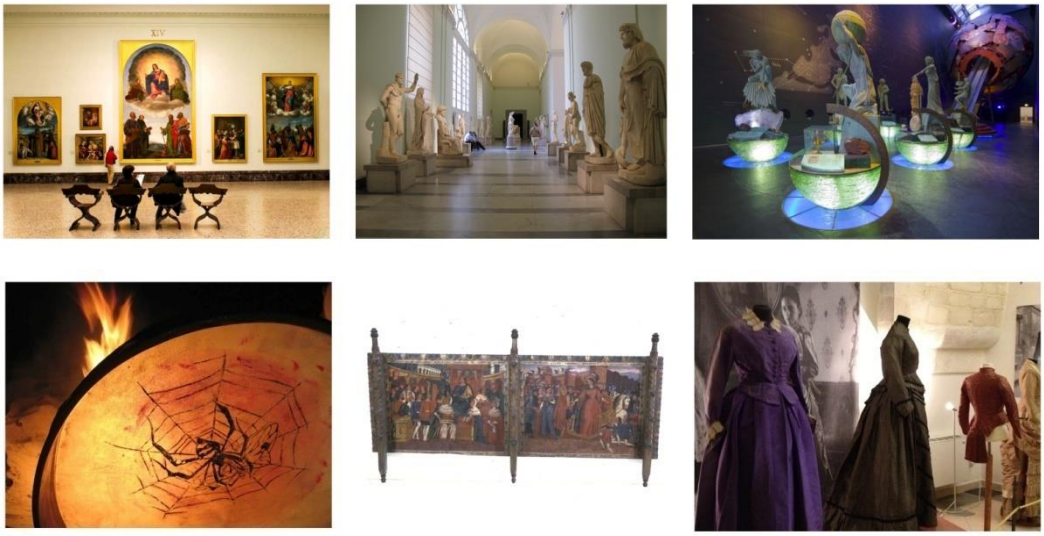


Figure 1.1. Classification museum according to the criterion of specificity of the user: a)art museum; b)archaeological museum; c) science museums; d)museum of Popular Tradition; e) museum of "material culture"; f)museum of costume.

The rate of computerization is another important element in museum classification [14], which can be so conducted

- *traditional museums not computerized* (some smaller museums, popular, lower grade schools);
- *museums at lower rate of computerization:* only catalogue and its consultation are computerized;
- *museums in average rate of computerization*: over the catalogue, it is possible to consult through terminals or computer the reproductions, slides, films of some of the documents and the information safeguarded; contemplates the presence of at least one consultation room equipped with the necessary terminals;
- *museums with a high rate of computerization:* most of the evidences and information have been reproduced and stored in a central memory and the consultation can take place both through viewing the object that by the terminal or magnetic media;
- *virtual museums:* the originals (documents) are not accessible (except in special cases) and all the activity of fruition and study is carried out on the basis of reproductions, using terminals, magnetic media or printing from computer support.

According to the criterion of the presence and consistency of the "heritage" [14], it can be distinguished:

- *museums without its own collection*, exhibiting artworks and objects from external collections (galleries, palaces of exposures etc.);
- *museums with their collections of artworks,* objects or documents, but which also expose periodically thematic collections from external sources;
- *museums exposing only its artistic assets*.

The classification criterion based on the characteristics of the buildings or areas that housing the artworks gives the following distinction between:

- *museums housed in spaces of building complexes with other destination* (small museums, schools, universities, municipalities, institutions);
- *museums housed in buildings or spaces originally designed for other destinations*: it is the very frequent case of historical buildings, but also of complex industrial archaeology, of significant buildings of modern architecture, etc. .; in these cases the location of a museum is also a strategy of preservation and conservation of the building;
- *museums housed in buildings or spaces specifically designed*;
- *museums environment*: urban or territorial contest bounded and preserved - often built by the placement, in buildings or outdoors, of objects and artworks historically homogeneous - to enable continuous and integrated experience of historical or cultural environment.

1.6.The risk and cultural heritage

In the probability that a damaging event may occur, the risk is defined by a statistical point of view, by relating the amount of damage on a specific object or individual of the population considered and the event that it produces [15].

In the historical and artistic context, the application of a risk model strictly statistical is not possible, because it should be defined a priori both the damaging event and the stochastic context in which the event can take place (the probabilistic mechanism that generates the event). If one considers that the damage suffered from a artistic assets is the result of a process of deterioration which cannot be broken down into elementary

events only expressible in probabilistic terms, and that the mechanism that produces the damage involves a high number of variables related to each other in such a way articulated and complex, it is easy to see that the historical and artistic context does not allow a measure of risk in these terms.
Were then identified the variables that affect the physical and social deterioration process to be used in the quantification of risk, putting in functional relationship the Risk with the Risk Factors.

1.6.1. The risk model

Given a set of elements, the risk is defined by a statistical point of view, by relating the amount of damage that produces an event on a particular object or individual of the population considered and the probability that the event will occur. Applying this approach to the cultural heritage we can be considered the historical and artistic heritage as the units of a particular statistical population and calculate the levels of risk to which such units are subject through the values that the Risk Factors can take for each of them. This implies that these factors can be quantified, or better measured, for each unit of the population and for each territorial unit to which the population insists. Consequently, the implementation of the information system and its database has been sized assuming the monument as a minimum units geo-referenced to scale of artistic assets (statistical unit of the population considered) for which the risk of loss must be calculated, and the municipality as a minimum territorial scale (territorial unit) that need to quantify the risk factors. In relation to individuals that populate the cultural heritage must be said that other asset classes and types, as panel paintings, paintings, archaeological evidences etc., as movable heritage, have been considered associated with an artwork/container, that best answers the dimensional scale.
If one considers that the damage suffered by an artwork is the result of a process of deterioration which cannot be disassembled into elementary events expressible only in probabilistic terms, and that the mechanism that produces the damage involves a high number of variables related to each other in such a way articulated and complex, it is easy to see that the application of a risk model strictly statistical is not possible because one should define a priori both the damaging event both the stochastic context in which the event can take place. Since the historical and artistic context does not allow a

measure of risk in these terms, then the physical and social variables that affect the process of deterioration to be used in the quantification of risk, have been identified putting in functional relationship the Risk with the Risk Factors. This means that the risk model described in the Risk Map of Cultural Heritage is a mixed model, which uses at the same time deterministic and statistical methods in the process of calculating the parameters and data analysis. From this mixed model is derived specifically the logical organization of the SIT MARIS. In other words, the difficulty of a risk measure purely probabilistic in practice has led to the construction of "*Risk Indicators*" to express its level through the calculation of indices, regardless of their possible correlation with an assessment of real probability.

Similarly, the measurement of the different Risk Factors was expressed in terms of Indicators of Risk Factors. In practice, these factors have been divided and organized according to a deterministic logic of cause and effect, which sees two main components:

- **Territorial Hazard (P)**, a function that indicates the level of possible aggression for a given geographical area, independently from the presence or not of artistic assets;
- **Individual Vulnerability (V)**, a function that indicates the level of exposure of a given artwork to the aggression of territorial environmental factors, according to the state of preservation of the artistic assets.

In this way it is possible to express the Risk as a function of these two components and to measure its intensity through the measurement of physical quantities, which contribute to their determination. The time *(t)* and the spatial location *(x, y, z)* of the physical quantities considered are the other variables introduced in order to know the distribution of the space/time parameters and phenomena that should be analysed: this allows the geographic territorial representation and its evolution over time.

In addition to the quantification of the physical quantities that, characterizing the domain of the vulnerability and the hazard, must be considered in their dynamic interaction, in their different incidence than the typological variations of artefacts and in the determination of different ratios of scale for the representation of information and phenomena, it had to proceed with the preliminary definition of the physical system of reference, that is the basic geographic elements that characterize the space in

which the artistic assets are located. Another basic determination was to quantify the elements that constitute the cultural heritage, in order to insert and consider cultural heritage between the basic geographic features.

The Charter of the distribution of the Italian heritage produced by the MARIS between 1990/95 appears as the first census of immovable property (architectural and archaeological) organized in spatial database. The source of which was carried out the census is of bibliographic nature and data were obtained from the Guides of Italy Italian Touring Club (TCI) and the Laterza Archaeological Guide.

1.6.2. The seismic risk of artistic assets

The model described above allows to express the risk as a function of the general components of Vulnerability (V), of each unit of the population, and Hazard (P), related to each territorial area on which the property is situated:

$$R = R(V_1, V_2, \dots, V_m; P_1, P_2, \dots, P_n) \qquad (1.1)$$

where R denotes the Risk Indicator and is set up as a weighted average of the indicators of vulnerability (V) and hazard (P).

In order to build the Risk Model have been identified three different domains, valid for both the Vulnerability and the Hazard.

The domains identified for Vulnerability (V) are:

- *Environment-Air* domain (defined by the feature of the surface), V_1;
- *Static-Structural* domain (defined by the constructional characteristics and static / structural), V_2;
- *Anthropic domain* (defined by use and safety), V_3.

Similarly, the domains identified for the hazard (P) are:

- *Environmental-Air* domain (characterized by climatic factors, microclimate and air pollutants), P_1;
- *Static-Structural* domain (defined by the geomorphological characteristics of the soil and subsoil), P_2;
- *Anthropic* domain (characterized by the dynamics of demographic and socioeconomic), P_3.

1.6.3. Vulnerability

The ICR competence in the specific field of conservation was used to select variables useful to define the state of conservation of the artistic assets and to develop a standardized format for use on the field for data collection. In this context have also been used also instrumental equipment to make geometric survey of artwork and provide graphic and photographic support to the data of 1st level used to define the state of conservation.

The preservation chart is divided into two sections:

- the first **personal-identification data**, where artwork is identified with the standard defined by the Central Institute of the Catalogue and Documentation (ICCD) for normal cataloguing activities;
- the second **descriptive**, aimed at detecting the state of preservation and the calculation of vulnerability, through metrics assessments and of the constituent elements and of the extent and severity of the different forms of degradation present on the artefact.

The chart also provides a set of photographic and graphic attachments and cartographic data.

Vulnerability is assessed through the many data collected during the study of the structure, of the three domains of surfaces and structures, as well as that of the mode of use of the artistic assets.

It is then used as an indicator of the level of exposure to damage in which the i-th artwork ("individual") is:

$$\begin{aligned} V_{1i} &= V_1\left(t, xyz, m_1, \dots, m_p, \dots\right) \\ V_{2i} &= V_2\left(t, xyz, n_1, \dots, n_p, \dots\right) \\ V_{3i} &= V_3\left(t, xyz, o_1, \dots, o_p, \dots\right) \end{aligned} \qquad (1.2)$$

where:

$m_1,\dots m_p$ are the variables used to quantify the state of conservation of the surface according to the level of urgency, severity and extension of several types of damage can assume in relation to the elements that characterize the "superficial" aspect of the i-th artwork;

$n_1,\ldots n_p$ are variables used to quantify the state of conservation of the structure according to the degree of urgency, severity and extension that several types of damage can assume in relation to the principal construction elements of the i-th artwork;

$o_1,\ldots o_p$ are the variables used to quantify the dynamics of use and safety of the i-th artwork.

1.6.4. Hazard

The hazard P is the component of risk that describes the physical process of deterioration of the artistic assets determined by the potential aggression exercised by the territory to the surface of the artefact, the structure and damage resulting from direct human activities for the i-th artwork possibly present territorial area of the City j-th:

$$\begin{aligned} P_{1j} &= P_1(t, xyz, a_1, \ldots a_n \ldots) \\ P_{2j} &= P_2(t, xyz, b_1, \ldots b_n \ldots) \\ P_{3j} &= P_3(t, xyz, c_1, \ldots c_n \ldots) \end{aligned} \qquad (1.3)$$

where:

$a_1,\ldots a_n$ are the variables used to quantifying the dynamics of the physical process of potential damage to the surface of the artistic assets on the basis of the values assumed by pollutants and climatic factors in the j-th territorial unit;

$b_1,\ldots b_n$ are the variables used to quantify the physical process of potential degradation of characteristics static/structural artistic assets based on the values assumed in the j-th territorial units from catastrophic dynamics of the soil and subsoil;

$c_1,\ldots c_n$ are the variables used to quantify the physical process of potential degradation of the artistic assets based on the values assumed by dynamics related directly or indirectly to human activity in the j-th territorial unit.

For the definition of the Static-Structural domain that defines the hazard six reference were taken among the phenomena that have the greatest impact on the structural

stability of the cultural heritage than the municipal territorial areas on which they insist: Earthquake; landslides; flooding; coastal dynamics; avalanches; volcanic.
This has allowed the identification of seven Indicators of Static-Structural Hazard, that are:

- Index of seismic Hazard;
- Index of landslides Hazard (sources: Ministry of Public Works and National Geological Service);
- Index of flooding Hazard (source: Ministry of Environment and National Geological Service);
- Index of coastal dynamics Hazard;
- Index of avalanches Hazard;
- Index of volcanoes Hazard;
- Index synthesis of static-structural Hazard.

For the definition of Hazard Environmental-Air two distinct and independent chemical-physical indexes have been identified: the Index of erosion and the Index of physical stress.
As regards the calculation of the **Index of erosion** is used the Lipfert's formula (1.4) [16]that allows to quantify the loss of material in the unit of time (μm/year). In the application of the formula the impact of individual factors is evaluated on the loss of material, considering also the closeness or not of the City to the sea (coast effect).

$$R = 18.8 \cdot Rain + 0.016 \cdot [H^+] \cdot Rain + 0.18 \cdot (V_{dS} \cdot [SO_2] + V_{dN} \cdot [HNO_3]) \quad (1.4)$$

where:

R	represents the surface recession (μm/year);
18.8	is the coefficient which represents the solubility of $CaCO_3$ in equilibrium with 330 ppm of CO_2;;
$Rain$	represents the rainfall (mm/year);
$[H^+]$	is the concentration of hydrogen ions (mg/l);
V_{dS}	is the deposition rate of sulphur dioxide (cm/s);
$[SO_2]$	is the concentration of sulphur dioxide in the air ($\mu g/m^3$);

V_{dN} is the speed of deposition of nitric acid (cm/s);

$[HNO_3]$ represents the concentration of nitric acid in the air (µg/m^3);

in particular

$18.8 \cdot Rain$	is the contribution of the rain clean, the so-called karst effect;
$0.016 \cdot [H^+] \cdot Rain$	is the effect of acid rain, the acidity is due to the presence of ions SO^4, NO_3;
$0.18 \cdot (V_{dS} \cdot [SO_2])$	is the deposition of SO_2;
$0.18 \cdot (V_{dN} \cdot [HNO_3])$	is the deposition of HNO_3

In addition to the Index of erosion is also considered an index of blackening based on the influence exerted by the particulate emissions, whose concentration at the municipal level can be estimated only approximately by the use of a box model that does not separate the carbon particles responsible of the blackening, from all others.

The **index of physical stress** takes into account the portion of the damage caused by the thermal and hygrometric interaction between the environment and the material and the cycles of freezing and thawing.

For the definition of anthropogenic hazard the reference is made to a deductive reasoning aimed at checking if the human pressure attributed to a given territory is in fact dangerous for present artistic assets. The anthropogenic phenomena identified as potentially responsible for adverse effects on the conservation of cultural heritage are reducible to three thematic areas:

- Dynamics of population density (understood as depopulation and overpopulation);
- Tourism pressure;
- Susceptibility to theft.

Five Indexes Hazard have been, therefore, identified and calculated:

- Index of depopulation;
- Index of overpopulation;
- Index of tourist pressure;
- Index of susceptibility to theft;
- Index synthesis Hazard anthropogenic

1.6.5. Risk Calculation

The methodology developed provides for the calculation of risk through the combination of two main components, the vulnerability and the hazard, in which the artistic assets are located. In practice, the risk function is constructed through the combination of factors which, on the one hand, characterize the state of conservation of the individual artworks and, on the other, are responsible for the deterioration mechanisms. The first factors define the level of the effects suffered by the artworks due to its exposure to the aggression of the agents of deterioration and the second the degree of potential aggression for a given territorial area.

According to available data, their updating and the qualitative characteristics of accuracy, resolution, spatial distribution, sampling time, extension of the territorial coverage is possible to know, through the calculation procedures, the level of territorial hazard, the Vulnerability Index of the single artworks and the Risk Intensity, and represent the corresponding spatial distributions, in a coherent and consistent on the Italian territory or on a single geographical area.

Depending on the degree of detail and accuracy of the data collected different levels of risk definition can be defined [17].

- First level: Territorial Risk

  The *territorial risk* is referred "to the state of susceptibility, to degradation process that characterizes the territory in which an aggregate of artistic assets is located". This indicator is then calculated as a function of the hazard levels and spatial characteristics of the aggregate of artistic assets in question (for example the number of monuments, type, etc.).

  $$R_t = n \cdot P \qquad (1.5)$$

  where

  P is the territorial hazard estimated at the municipal level

  n is the number of georeferenced artworks on the territory.

- Second level: Individual Risk

  The *individual risk* is related "to the state of susceptibility to degradation process of a single artworks" and is represented by the product of the local hazard level (P) and vulnerability (V_k) of k-th artworks present on the territory in that given

municipality.

$$R_i = V_k \cdot P \tag{1.6}$$

where

P is the territorial hazard estimated at the municipal level

V_k is the vulnerability of the k-th artworks.

- Third level: Risk Local

  The *local risk* refers to the single artistic assets, but the hazard is calculated locally to sub-municipal level, multiplying the hazard (P_j) in the surrounding the artworks for the vulnerability (V_k) of the artwork itself [18].

$$R_l = V_k \cdot P_j \tag{1.7}$$

where

Pj is the territorial hazard estimated near the artistic asset

V_k is the vulnerability of the artistic

This is the most difficult level to get, because for many hazard factors there are no data available in a sufficient scale of detail and, at the same time, there aren't homogeneous and uniform data throughout the national territory.

2. Knowledge: Restoration, History, Technology. A review

2.1.Protection, restoration, conservation and cataloguing

In order to establish a protocol of relief for the cultural heritage, which has as its purpose as knowledge as the protection and conservation over time of investigated heritage, it is necessary to focus on the different methodological approaches that have led to a differentiation on the contents of the terms protection and conservation, while seeking to emphasize the contribution that the history and new technologies have provided in this large sector especially in the cultural tradition of our country.

As reported by De Vivo [19] "*the origins of the cataloguing of cultural heritage is a matter which has been given a different action in time depending on the level of detail achieved by the various contributions that have addressed this, which rarely have dedicated themselves directly, taking more often as object the evolution of the institutional service of protection in general. As regards the birth of this activity today historiographical reflection on the subject has produced the idea of cataloguing developed for a situation of real need.*"

From the seventeenth century is felt in the various Italian states the need to protect the artistic heritage, especially in the context of the birth of collecting that instigated the export of works of art and antiquities. It is in this period that begins to be approved decrees and that are created commissions aimed at cataloguing and protecting both monuments and the artworks, through detailed and systematic tools coming to the formation of a real catalogue.

The 1773 corresponds with the date of issue by the Venetian Republic, and through the establishment of a consultative body known as the *Mighty Council of X (ten)*, a measure in which was ordered the compilation of a catalogue to oppose to the" *scandalous facility with which they were arbitrarily removed and sold models ... the best and most famous existing paintings in the churches, schools and monasteries of the Dominant and the surrounding islands …*"[2] [20]

The task of drawing up the "*Catalo of all the most important existing paintings in the churches, schools and monasteries in the city, with the identification of what they represent, and the names of their authors*" was given to Antonio Maria Zanetti, appointed Inspector of

[2] Decree of the Council of Ten (Venice April 20, 1773)

public paintings, with the task of drafting a descriptive *note* for each artwork of their state of preservation and their location, and make half-yearly checks. The presence of the artworks within that catalogue would have resulted in the authorization request in the case of move of artwork and the absolute prohibition of sale [21].

Since the eighteenth century the protection thus has assumed the dual task of knowing and preserving, especially for the new rational consciousness and the need for a scientific promoted by the spread of the Enlightenment.

Similarly to the Venetian experience, the Papal States made clear the link between knowledge and conservation in the edict of Cardinal Joseph Doria Pamphili, pro-chamberlain under Pope Pius VII, which represents one of the first legislative instruments capable of safeguarding the cultural heritage of the state. In Chirograph, enacted after the fall of the Jacobin republic and significantly entitled "Preservation of Monuments and Fine Arts productions", was ordered to the eleventh point that "*all individuals who have ... one or more ancient objects, or otherwise remarkable of Art, ... in Rome and all over the state, should give an exact notes, distinguishing each piece ...*"[3] [20] and it was stated that annual inspections by Inspectors General for Fine Arts or its agents must be made. In this edict, in particular the last article, was included the artworks purchase by the Government of the Pontifical to be exhibited in museums, if this was one of the few measures of preservation and conservation of the work.

It then begins to feel the need for an inventory of artistic assets belonging to the state and particularly of movables heritage, because subject to greater risks [19].

At the beginning of the nineteenth century were recorded important theoretical revolutions within the laws for the protection of monuments inspired mainly by the changed perception of history and to the change of attitude by man against material evidences *"that represented the development of that history"*[4]. In 1810 was established the "Special Commission in charge of the inspection and conservation of ancient and modern monuments of the city of Rome and the Roman States" with the task of drafting a report on the state of conservation of the monuments of particular artistic interest. However, the most interesting arrangement dictated by the Commission was

[3] Chirografo del card. Doria Pamphilj (1° ottobre 1802)
[4] Cfr. De Vivo "*Il rapporto catalogazione/conservazione…*" op. cit. p.13

to accompany the catalogue with a plan planned interventions that the monuments would have to undergo. This action demonstrates the importance attached "*to the link between cognitive interventions and conservative interventions, among the investigation proceeds on heritage and operating decisions for heritage conservation*" [19].

The Edict of Bartolomeo Pacca chamberlain (April 7, 1820) is worth mentioning for having provided the first cognitive tools to verify the real condition of the assets to be protected. In this edict was expected cataloguing of all objects of antiquity and of art in churches or ecclesiastical establishments. The catalogue thus understood becomes "*priority tool for reconnaissance, knowledge and protection of all those artistic assets which, in the Rules for the Auxiliary Boards of Fine Arts, published in 1821, will be declared "public law*" [22]. Moreover in the Edict Pacca for the first time we talk about the restriction, because any operation expected on artwork had to be submissive to the authorization of the same chamberlain. As evidenced by Negri Arnoldi, the legislation papal anticipates the modern "institution of notification (restriction of the artwork, right of first refusal, the export ban abroad)" [21], establishing the principle for which the cultural heritage belongs to the community so that the public interest must prevail on that individual, and on these principles the Italian legislation subsequent until Cultural Heritage Code of 2004 will be based.

As emphasized De Vivo with the edict Pacca the cultural object is analysed from a different perspective, since this is "*no longer considered in its singularity physical and no longer judged by the aesthetic criterion, but seen as a work set in an original territorial context, in turn characterized by a network of relationships which, adding value to the single episode or artistic fact, creates a real cultural system*" [19].

As it is known, the birth of the kingdom of Italy as a unified nation did not produce an immediate legislation for the preservation of monuments and artistic heritage. For over half a century remained in force the legislation of the various provisional governments, which were formed after the official birth of the Kingdom in 1861, while remaining alive the debate on the formation of a single law for the protection of antiquities and monuments. In this context also the need to draw up a complete catalogue was

warned. This catalogue had to enable control of the texture and the state of preservation of the works on the national territory.

In 1870 with the Minister Correnti there was the creation of a subcommittee of experts within the Council of Fine Arts, which had the task of carry out studies aimed at identifying declared national monuments. In addition, this committee had to provide for the census of the national heritage through an accurate documentation, and also had to identify those which could be the best conservation strategies.

In 1875 the first Official List of Monumental Buildings was published, and approved by the Minister Bonghi, [23]. The list included the medieval and "modern" architectural monuments, even if the modern monuments presented their nature of monumentality in only limited portions of their development. The publication of this list caused several controversies, both because within it was not enclosed the entire cultural heritage present on the Italian territory, being limited to a certain chronological period, and because the "historical value" assumed a secondary role compared to the aesthetic value. In this context it should be specified that, the concept of historical value, as well as identified by Alois Riegl, will only later envisaged as a definite factor, singular, of the development of some field of human creativity, and it is now understood as higher as clearly expressed in the original form of the work.

In 1877 was issued a new ministerial circular to facilitate the cataloguing of the national heritage and complete the first list published by Bonghi, through a simple tool and essential. To facilitate the compilation of the catalogue, the artistic assets were divided by period of construction, taking the fall of the Roman Empire as a time reference. The monuments dating back to an earlier era were considered archaeological monuments, the rear ones instead medieval monuments. To each artistic asset found had to be provided a description of the state of conservation and reported, where possible and documented historical information to understand the transformations undergone by the artwork over time. The desirable outcome was, in fact, a catalogue of all the works that should have been subject to protection.

The problem of drafting of an updated catalogue of national monuments and the recognition of its purposes was one of the main limitations to the development of policies for the conservation of cultural heritage, as in the last years of the nineteenth

century were outlined contrasting positions on the cataloguing of artworks. According to some the inventory had to be an instrument at the service of protection and should therefore be seen as a fast tool. According to others this fast cataloguing could be omitted some fundamental aspects for the knowledge of the monument, for which the cataloguing was to represent *"the scientific basis on which to build the assessment and intervention on the cultural heritage of the nation"* [19].

It should also be noted that in recent years, in addition to issues related to the cataloguing of national heritage, were promulgated the first *Standards on the restoration of paintings*, drawn from Cavalcaselle (circular no. 508 bis of 1877); *Standards on the restoration of the frescoes* were instead published in January 1879; while a year later were published the *Standards on the restoration of the mosaics* [22].

In these standards, beyond some technical differences on what to do, was identified a criterion for the articulation of the restoration. This was divided into two separate moments, in which the first is aimed at the elimination of the causes of deterioration and at the structural consolidation to which followed the repair of the damage, the second aimed at reintegrating lacunae through the mimetic reconstruction, for neutral colours, of the missing parts.

In any case the intervention was to be controlled by a member of the local conservative provincial Commission, who had to send to the Ministry a special test certificate.

In architecture and monumental context the regulatory measures were approved by Giuseppe Fiorelli, who held the position of general manager. With the circular prepared July 21, 1882 (no. 683bis) *On Restoration of Monumental Buildings*, Fiorelli emphasized the importance of knowledge of the building as part of the restoration, which represented a fundamental moment both to analyse the story and the historical-aesthetic features and the materials used. According Fiorelli the preliminary study allowed to observe stylistic features and to produce a report on the damage present on the artwork. As concerned the operations of restoration was possible to distinguish the parts considered of particular artistic value, for which one had to intervene with limited action to stop the degradation and remaining parts for which instead could perform reconstructions also complete [24].

Another important document in the context of the restoration, understood in the modern sense, was the chart rated within the IV Congress of Engineers and Architects of Rome (1883), in the document, the text of the circular Fiorelli was taken up almost entirely by Camillo Boito. The result of the Congress of 1883 was the enactment of what is considered one of the first important papers of the restoration, the "manifesto" of the modern conservative restoration.

Since these documents are then derived restoration theories and development of methods and criteria for intervention that mainly characterized Italian culture from the first half of the twentieth century and to these were inspired by some of the articles contained in both the Athens Charter of 1931 that the Charter of Venice 1964.

However between the theory and practice of restoration are found not a few inconsistencies, examining, in fact, the documentation on the restoration of the monuments seems to have been Adolfo Avena the only to operate according to the recommendations specified in the documents mentioned above, recommendations were disregarded by the same Boito, who despite having passed the stylistic restoration of Viollet-le-Duc, in practice adopted systematically reconfigurations arbitrary monuments.

The distance between statements theory and practice in the field of architectural restoration is now peacefully accepted by researchers, although it is not put sufficient emphasis on the obvious contradictions that were to occur when they intervened on mural paintings, which are structurally related to the buildings and they requiring the intervention both of the architect and of the restorer of paintings.

The operation conducted by Luca Beltrami on the Castello Sforzesco in Milan in 1893 is different, in his intervention he completely rebuilt the tower collapsed in 1521 on the basis of a detailed and accurate documentary research that allowed the architect to design and build by analogy the stylistic missing parts.

The ability to mimetic revival had already been recovered during the National Exhibition of Turin in 1884, when it was designed and built a medieval village in the Valentino Park. On this occasion Boito pronounced one of his most famous contributions to the theory and practice of nineteenth century restoration titled The restorers (7 June 1884), in which the famous quotation of Didron (1839) was recalled:

Relating to ancient monuments, it is better to consolidate that repair, it is better repair that restore, it is better restore that redo, it is better redo that adorn, in no case should add anything, especially anything suppress.

Both in practice as in the theoretical development formulated by Boito are found deep differences with the views expressed in painting by Cavalcaselle, which have their roots in a more general protection activities based on the cataloguing of the artistic heritage of united Italy.

As noted previously, in the protection of monuments first the regional representatives, and then architects directors had the task of drawing up the List or Inventory of Monuments, based on different classes of importance, but for Cavalcaselle cataloguing represented the cognitive dimension on which to base the activity of restoration and build a differentiated view of historiography in the different regional realities.

The twentieth century was opened with the approval of the new law on the protection of cultural heritage: the law n. 185 of 12 June 1902, also known as Nasi law. This was the first real law concerning the Cultural Heritage. It established a National Union Catalogue and introduced the right of first refusal by the State together with the prohibition of export of movable heritage.

Despite the changes introduced by this first legislative provision dedicated to cultural heritage, the law Nasi had a relative strength. The reasons for its ineffectiveness are to be found in the anticipation of a catalogue of the monuments that would include all the goods to be protected and that it was a tool of cognitive support to the protection, resulting from a thorough cognitive investigation [21]. This operation would have been very difficult especially considering the Italian cultural heritage, and it would have required time actuations unsustainable.

In 1907 the Royal Decree n. 707 concerning the Catalogue of things of historical, artistic and archaeological was issued. This decree stipulated that the cataloguing of cultural heritage should be the prerogative of internal staff to the Ministry or specialized employees outside to the Ministry, and that the catalogue should be completed to take the form of an inventory with administrative and cognitive functions [19].

Into national law the legal relevance of the catalogue had a brief life because the application of the rules on conservation and protection to goods present only within

the catalogues would have resulted in excessive time. It is therefore with the law Rava that the conception of inventory-catalogue has been changed. It was expected then that public goods were placed in a "descriptive list of things", while for artistic assets belonging to individuals, the system of protection was applied only in the event that it had been sends a notification of interest to the owner of artistic asset.

This law remained in force until the enactment of subsequent laws n. 1089 and n. 1497, 1939 ("Bottai" laws) that did not alter the content, but corrected some defects [19].

Another essential step is the foundation of the Central Institute for Restoration. Its foundation is subsequent to the first laws of protection and is directly derived from these. The ICR is a national structure for research and training in the field of conservation of cultural heritage, which since its establishment has had the aim to set the task of restoration on a scientific basis and to unify the methods of intervention on the artworks and archaeological discoveries, overcoming the traditional concept of empirical restoration.

The story ICR through its managers, among which we remember Cesare Brandi and Giovanni Urbani, punctuates the events of protection in Italy: from the post-war reconstruction, to the controversies on "cleaning controversy" in 1947 and in 1960, to Commission Franceschini documents in 1967, at the birth of Ministry of Culture in 1975, to the searches on the protection of monuments from the seismic risk in 1983, transferred into the risk map for Italian cultural heritage [25]. All stages, only listed here, of a slow improvement that from the restoration leads to conservation as periodic maintenance that can prevent the alteration and destruction of cultural heritage.

From the analysis of the sources and documents it is clear the fundamental role, acknowledged today, that cataloguing of the artistic assets takes in the phase of knowledge of cultural heritage for the protection and preservation, and it is in this context that the research project is inserted through the development of a protocol for fast relief to the cultural heritage in seismic areas.

3. The role of the representation

3.1. Introduction

The implementation of policies to seismic prevention, whose finality is the safeguarding of protected artistic assets, requires knowledge, on a regional scale, of the risk which existing artefacts are subject.

To meet this demand, in order to acquire in a short time a homogeneous and accurate knowledge of the risk of cultural heritage, have been drafted the "*Guidelines for the evaluation and reduction of seismic risk of cultural heritage with reference to technical standards for buildings*" [26] with the intent to specify a path of knowledge, to the seismic safety assessment and the design of possible interventions, in order to make a final judgment on the safety and seismic knowledge guaranteed by the intervention, referring to the existing masonry buildings , in particular those belonging to the protected heritage.

The knowledge of the historical buildings in masonry is a fundamental prerequisite both for a reliable assessment of seismic safety and for the choice of an efficient intervention of improvement, repair or local intervention. This can be achieved with different stages of study, depending on the accuracy of survey operations, historical research and experimental investigations in order to establish an accurate model of interpretation of the real structural behaviour of the building analysed.

The path of knowledge can be traced to the following phases:

- *identification of the building*, its location in relation to particular areas of seismic risk, the relationship with the urban context. The analysis consists in a first schematic survey of the artefact and in the identification of any artistic assets which may affect the level of risk;
- *geometric survey of the building in its current state,* complete description of the factory including cracking and deformation phenomena;
- *characterization of the building evolution,* understood as a sequence of transformations steps for construction;
- *characterization of the structural elements,* both as regards the materials and as regards

the construction techniques, with particular attention to the details of construction and to the degree of connection between the elements;

- *identification of materials,* their degradation and mechanical properties;
- *knowledge of subsoil and foundation structures,* referring to the variations in time and possible instabilities.

For the seismic safety assessment and design of the interventions of cultural heritage is therefore necessary to reach an adequate knowledge of the structure, in order to identify the characteristics of the elements that determine the structural behaviour. It can be obtained with different levels of detail, according to criteria based on the accuracy of the reliefs and historical investigations, on the recognition of the use of rules of art, on the identification of the level and type of damage, the ability to reconstruction of the history of the building in relation to seismic events, and possibly on the results of experimental investigations, taking care to assess the impact of any evidence, also only weakly destructive, on the preservation of the building. In the case of experimental tests, therefore, one should be limited to those actually required to perform the analysis.

On the basis of the knowledge level reached will be defined an appropriate confidence factor FC between 1 and 1.35 to grade the level of uncertainty of the model.

The confidence factor may also be determined by defining different partial confidence factors FC_k ($k=1,4$) (3.1), on the basis of some numerical coefficients (Table 3.1), whose values are associated with the four categories of investigations and level of knowledge reached.

Table 3.1. Definition of levels of analysis of the investigation on different aspects of knowledge and related partial confidence factors.

Geometric survey	Identification of historical and constructive specificity of the building	Mechanical properties of material	Soil and foundation structures
complete geometric survey $FC_1 = 0.05$	restitution of the hypothetical construction phases based on a limited relief of materials and construction elements associated to the understanding of the events of transformation (documentary research and thematic) $FC_2 = 0.12$	mechanical parameters inferred from data already available $FC_3 = 0.12$	limited investigations on the ground and foundations, in the absence of geotechnical data and availability of information on foundations $FC_4 = 0.06$
complete geometric survey with photographic restitution of cracks and deformation	partial restitution of the construction phases and interpretation of the structural behaviour based on: a) limited relief of materials and construction elements associated to the understanding and verification of the events of transformation (...); b) extensive relief of materials and construction elements associated to the understanding of the events of transformation (...) $FC_2 = 0.06$	limited investigation of the mechanical parameters of materials $FC_3 = 0.06$	availability of geotechnical data and the foundations structures; limited investigations on the soil and foundations $FC_4 = 0.03$
	complete restitution of the construction phases and interpretation of the structural behaviour based on an exhaustive relief of materials and construction elements associated to the understanding of the events of transformation (documentary research, any diagnostic investigation) $FC_2 = 0$	extensive investigations of mechanical parameters of materials $FC_3 = 0$	extensive or exhaustive investigations on the soil and foundations $FC_4 = 0$

$$FC = 1 + \sum_{k=1}^{4} FC_k \qquad (3.1)$$

Analysing the path of knowledge outlined in the Guidelines it is possible to observe how this comes close to the scientific-systematic method outlined by many experts in the field of restoration in order to deal with a correct intervention of integrated conservation of the architectural heritage. In view of these considerations it is necessary to consider the similarities found between the scientific-systematic method and the path of knowledge, starting from the comments that have been made in the restoration by many experts, starting from E.E. Viollet-le-Duc (1854).

3.2.Methodology of the technical intervention

This paragraph summarizes the significant features of methodology of the technical intervention reported by Di Stefano in [27].

"In order to address an integrated conservation intervention on architectural heritage it is necessary to define a logical method based on a clear understanding of the purpose to be achieved and the conscious will to achieve it.

It should be noted that there are no general methods that can solve univocally the problems of the integrated conservation. It is known, in fact, that the method is not a complex of fixed rules and unrelated to the continuous dynamic of thought but constitutes an ordered set and subsequent of acts, based on a series of intellectual operations, controllable and repeatable, allowing the mind, through connections and relationships between concepts, and to implement the process of acquiring knowledge. In this sense, method means guiding principle, criteria that inform the activities, standard which determines behaviour and choices for obtaining valid results for a particular purpose.

In order to promote the conservation and restoration of architectural heritage it is possible and appropriate to apply the logical forms according to the scientific method-systematic, so, in conducting the operations necessary for the conduct of technical-scientific activities of conservation, it is required a precise way to the goal (μετὰ ὁδός), a method.

E.E. Viollet-le Duc [28] has the merit of having traced the operating line for the restoration, in fact he writes: "*First of all, before being an archaeologist the architect in charge of a restoration must be proficient manufacturer with experience, not only from the general point of view, but also from a particular point of view; that is, he must knowing the*

constructive measures in use at different times in our art and in different schools" and insists above all on fundamental importance of technical knowledge "*If the architect in charge of the restoration of a building must know the forms, styles ... he has even more, if possible, to know the structure, anatomy, temperament, because, first of all he must do live it.*"

Furthermore, it is necessary to consider the so-called rule of case by case basis, which requires that the monument to be restored is subjected to a specific and singular study. This rule is based on the awareness that any solution must come from the strict application of a uniform and common method, which should result from a process of logical research, characterized by the rational analysis, orderly, controlled and consistent, and also repeatable, and self-correctable and respectful of necessary assumptions on which it is based.

Three essential moments can therefore be defined:

1. that of *connotation*, in order to know, from all points of view and as accurately, the object at issue, from the commencement of the operation that is going to make;
2. that of the *technical and structural restoration*, which identifies all available means to ensure the physical preservation of the object;
3. that *of the use of the object itself*, for its aims and in the limits which the integrated conservation allows.

The steps of the method can therefore be summarized in:

1. *cognitive analysis and instabilities diagnosis* (coincides with the phase of the connotation);
2. *possibility of intervention or design scheme*;
3. *verifications*;
4. *operational decisions and executive project* (coincides with the phase of the restoration technician and use);
5. *execution phase*.

This sequence does not end in step 4 because during the executive phase new elements will be acquired that give rise to in-depth of the cognitive analysis that would result in the need for iteration of the sequence of acts and also changes of the final choices.

Another important observation is that relating to the multidisciplinary nature of the process. The restorer architect, to approach the protected heritage according to the

scientific-systematic method outlined, has to build a team of consultants, chosen on the basis of the scientific requirements he is be facing. It should be noted, first, that what guides and directs the conservation action is the historical-critical consciousness, implicit in the aims to be achieved. Hence the primary contribution of the humanistic and historical subjects that provide the elements of judgment and allow to determine if of an object belongs or not to the cultural heritage to be protected, that is to say, to make the choices from which the restoration operation starts. The physical and chemical sciences provide essential applications in different sectors from dating to the pathology of materials both in the analytical phase leading to the diagnosis, and in the phase of consolidation and preservation and conservation.

Traced the framework of competences which it may be necessary to resort, let us examine the phases in which the method is divided.

The first is the one that should allow to know the artwork of the restoration, with its high precision and in all its details, not only in its present state but also in the different periods of its existence. This is the first operation to be performed in the knowledge that cannot be completed during the first approach. In fact, it requires, on the one hand, a long time to conduct such research and for the evaluation of the collected data and, on the other hand, possibility of carrying out site investigations, essays and experimental tests, as well as the use of different equipment.

The cognitive operation will continue without interruption during the execution of the works. However, the approximation of the cognitive analysis may be contained in reduced limits carrying out the analysis on four lines of research, which must be developed simultaneously and, gradually, coordinated among themselves. Therefore, all the collected data can be compared, evaluating their reliability and they can be identified by partial investigations performed with increasing precision, until reaching of a set of elements that can ensure a sufficient knowledge to make a reliable diagnosis and a first plan design.

The four strands which should be followed in most cases are aimed to the analysis: 1) historical; 2) morphological and dimensional; 3) static features; 4) materials and structures.

The *historical examination* requires the knowledge of everything that has been published both specifically on the building in question, that on the urban or local area which now houses it, going back to the period when in it there was no building.

To these same purposes must be addressed the investigation in the archives where they can be deposited documents concerning the construction of the building, its transformations, restorations, partial destruction, the names of subsequent owners, architects, artists and artisans who have worked as well as all the dates relating to facts and events, even if, as a first approximation, may seem insignificant or marginal.

Such investigations are also aimed at finding iconographic material of all types: floor plans, drawings (constructive or not), paintings, models, photographs, etc.

It is to make a thorough research, both of historical and urban planning that of architectural history.

In parallel the *morphological examination and dimensional* is done, through a thorough photographic documentation, both of the interiors and of exterior, with general views and details of various interests, taking care to date and catalogue the material collected and to report the location of the points of broadcast of single shots.

Moreover, the relief of the building is carried out. This is an extremely important operation but also extremely difficult operation. It is, in fact, of representing the building, as a whole and in the component parts, as well as actually presents itself at the time of the analysis, with all its irregularities, deformities, damages, etc. The various materials present, the constructive systems that are used, should be reported appropriately.

Together with the two analysis mentioned above, it is necessary to perform the examination of the *static features*. To this purpose it is necessary to verify the presence of one or more structural organisms and, within each, identify the original structures and the additions, identifying their forms and peculiarities, in order to understand the different static functions of the single structure.

The fourth line of investigation is aimed to the *analysis of materials and structures* also through instrumental investigations on the structures themselves. They tend to determine the mechanical characteristics of the materials, through tests, carried out in work, on the stones, mortars and masonry blocks

Considering the cracks in the walls, it is useful a preliminary observation which tends to determine if it is "apparent collapse" and that is to say if the damage, for example, only affects the plaster, if it matches the holes of passage, to chimney flues or other pipes recessed or openings and so on. In addition, the cracks must be observed uncovered, that is, without plaster or other coating. If the cracks, then, concerns the masonry should be observed if the crack corresponds to the mortar or the stones and if it is superficial or cut the wall thickness.

Then, another series of observations should be conducted for the relief, both metric and photographic, of cracks and deformations, which must be represented graphically on the graphics relief. This graphical representation, which allows the reading of crack patterns, must then be refined and supplemented by a systematic photographic representation. Similar processing will be performed with respect to possible deformations and displacements of structures (translations, rotations, etc.).

When it is necessary, measurements will be carried out, protracted in time, in order to follow the evolution of the progression of instabilities.

The results provided, both in progress and in conclusion, from the four research areas are compared with each other, in order to assess the reliability of news and information and the iconographic material. In addition, the integration of data and results from different lines allows other important analysis. For example, the reading of historical information, through dimensional controls, can facilitate the knowledge of the phases of construction, the recognition of constructive elements and, therefore, the identification of the original structural models. Therefore, being able to correctly determine the cracks frameworks, the formulation of the diagnosis of instabilities can be reached.

Furthermore, from these processes of comparison and integration of results may also arise the need to direct research in specific directions from which find additional items to complement the cognitive frameworks already identified. In this way it is possible to make, gradually, judgments both critic type, on the cultural historical and artistic value, of the buildings in their current form and of the elements that make it up today, both technical, about the structural characteristics and the stability conditions, both general and particular areas.

This series of considerations allows to have other important processes. First, it is possible to represent the successive phases of construction of the parts of the building, and also the changes and other interventions that are followed over time. The static patterns present in the different structures of the building can be identified. These schemes can overlap with those originating in or derive from them as a result of changes occurring over time. Once identified these schemes and distinct bearing structures from non-bearing structures a weighted analysis can be performed and, knowing the mechanical properties, the structural strength assessment can be made.
Finally, providing the data above, the cracks frameworks and the trend of their progression it is possible make a reliable diagnosis of instabilities (Phase 1: analysis and diagnosis).
At this point, sufficient information to proceed to identify design solutions (phase 2: hypothesis) are available. This information will have to satisfy the needs of both the static consolidation both of integrated conservation, and therefore of the valuations and use, the building in question."

3.3. The graphical representation of knowledge

In order to reach the development of an appropriate model, and interpretation of the real structural behaviour of the artefact analysed, it is necessary that each phase identified in the path of knowledge [26], or in the method outlined above [27], is accompanied by appropriate drawings
Historical analysis is directed to the knowledge of construction methods that gave rise to the object, intended as synthesis and material expression of a complex system in which are intersected aspects of technological culture, of social and economic history well as artistic, this is upgraded by reports and drawings, which analyse the evolutionary phases both in plan and elevation.
Historical knowledge, as outlined in the previous section, is oriented towards the study and investigation of sources complementary to the traditional ones, such as technical documentation, contracts for buildings and evidences transmitted through changes in ownership. Historical knowledge of this type responds to the quest for understanding of the historical built, as has been said, that represents in its specificity an opening in the historical dimension of the techniques, of ways of doing things, variables in

geographically and historically circumscribed areas, each characterized by a deep language, variable over time in different forms and connected to technological variants, to different construction practices and materials processing, also determined by the conditions of the context geophysical well as from the circuits of architectural culture in the widest sense [29].

Historical knowledge, drawn from indirect documentary sources regarding the building, is accompanied by the analysis of archaeological type, through which the material of the building becomes itself, as is, document, direct source for its own history. The stratigraphic relief, as a method of analysis acquired by archaeological discipline, deserves particular interest as a diagnostic tool in non-destructive methods and it aims to historical knowledge of the building through the analysis of the high, the juxtaposition of the parties, the nature of materials, degradation, with the graphics support of the geometric relief and of the photographic relief set according to appropriate representation methods (photogrammetry, rectifications).

The concept of history subtended by this approach to the knowledge of the past of the artefact reflects in coherent manner the knowledge of the continuous history that develops in a slow movement of long duration. The story of the artefact is not understood through the identification of events, chronologically determined and static, but as the expression of a continuous movement, and not unidirectional history. This movement also includes the negative facts, the silences, the shaded areas, what of which there's no more memory, as the demolitions, the trace of which, if surviving, is readable only by studying the relationships between the parts and not in a discontinuous and abstract chronological succession.

Essential, in the path of knowledge, is the graphic restitution of the data collected during the geometric relief of the complex, survey that must be referred to both the overall geometry of the organism than to the individual constructive elements.

The stereometric description of the building involves the identification of the features plano-altimetric of the building, at every level, and therefore must be recognized: the geometry of all the masonry elements, vaults (thickness and profile), the horizontal structures and roofs (type and warping), stairs (structural type), the identification of possible niches, cavities, openings closed, chimneys and nature of foundations. The

results of the survey are carried through the development of plans, elevations and sections, which will identify the structural scheme resistant [26].

Since the drawings of geometric survey are obtained from a process that is full of difficulties, related for example some places are inaccessible, all the information collected must be verified. This is possible by using tools that give quick survey and a restitution accurate even in the case of complex elements, and techniques of direct investigation (endoscopy) or indirect (thermography, ground penetrating radar, etc.) for the spaces not accessible.

The ultimate aim of the geometric survey is the definition of a model to use in the seismic analysis, for this reason the most significant points for the assessment model should be identified, such as horizontal structures and vaulted systems, the nature of their support on the walls. Also the masses of the elements and the loads imposed on each element of the wall should be fully determined.

The representation of the deformation and cracking framework is crucial. Deformations and cracks should be classified according to the geometry, kinematics nature and thus be associated with any damages mechanisms. A correct knowledge of the cracks and deformations present in a complex makes it possible to identify the causes and the possible evolutions of the structural problems of the building.

The graphic compositions then are enriched of information coming from the photography and geometric survey, enabling the understanding of the differences and to know the structural differences and constructive of buildings, of information derived from historical analysis resorting also the means of the stratigraphic survey and with the support of the graphic geometric survey and photographic survey set according to appropriate representation methods (photogrammetry, rectifications).

The increasing awareness of the need to make it accessible to a non-expert community the understanding of the issues of conservation has contributed to innovations in the methods of representation of a historical artefact, in a multimedia form in which photographic images or three-dimensional representations facilitate the understanding of architectural organism [29]. The realization of a *hypertext* in which are located the various phases of the analysis of the complex has offered the opportunity to make immediate control of knowledge directly on the network. The compilation of the

different fields where it is possible organize hypertext allow to have a kind of container in which to enter data gradually acquired, to intersect the results through transversal paths that pass over any scheme strictly procedural. In this type of organization of the multiple paths these processes become, in the form of graphics solutions, notes, annotations, illustrations of various kinds and sizes, part of a heritage available for analysis at a later date, comparisons, discussions in the process before, management and monitoring, then.

Hence the need to represent through accurate drawings the knowledge acquired as part of historical investigation, which should be directed to the understanding of constructive methods which have given rise to the artefact, intended as material synthesis and expression of a complex system in which are intertwined aspects of technological culture, of social and economic history as well as artistic.

4. Artistic Limit State (ALS)

4.1. Principles and criteria of Guidelines

As reported in previous chapters, the "*Guidelines for the evaluation and reduction of seismic risk of cultural heritage*" [26] have been drafted with the intent to specify a path of knowledge, assessment of the level of security against seismic actions and design of any interventions to the protected cultural heritage. The aim is to make the final judgment about the safety and conservation guaranteed by seismic improvement, repairs or local, as required by Article 29 of the Code of Cultural Heritage and Landscape [5].

The acquisition of a sufficient level of security and protection in respect of seismic risk is guaranteed, for architectural artefacts of historical and artistic interest, by respecting three limit states: two of them reference at the limit states defined by the NTC, while the other one is specific for cultural heritage.

Generally , for the artefacts belonging to the cultural heritage, the achievement of a sufficient level of security is guaranteed through the respect for the Limit State of Protection of Life (LPS), in the case of rare and strong intensity earthquakes, and for the Damage Limit State (DLS) for earthquakes less intense but more frequent. In the case in which the artefact analysed has some characteristics in parts of it or localized in defined areas of the same environment such that a reference earthquake with intensity and frequency appropriate can cause damage to parts or elements that entail a irretrievable loss to the cultural heritage, it is necessary to define a new specific limit state called Artistic Limit State (ALS). It is defined as: *following an earthquake of appropriate level (usually that taken into account for the damage limit state), the artistic assets contained in artefact suffered minor damage, such that they can be restored without significant loss of cultural value, intending for artistic assets both decorations, painted surfaces, architectural elements (altars, organs, balustrades, flooring etc.) and goods and chattels (altar, baptismal fonts, statues, etc.).*

This LS is applied to items such as decorations on the walls that are particularly sensitive to damage, to complementary parts of architecture as pinnacles, statues and objects however constrained to the walls or, in some cases, for rare masonry elements

the loss of which could not be compensated from the number of existing elements similar. The identification of this new LS was necessary because, although it is possible to take the analysis modes for the DLS, the items above may present serious damage even without the presence of structural damage. In these cases specific analysis may be necessary, limited to particular sections or macro-elements that will be analysed with specific criteria and evaluations. Therefore the analysis to the Artistic Limit State is done exclusively at the local level, in the parts of the building that are characterized by elements whose loss would result in irreparable damage to cultural heritage, as not recoverable with the procedures and methods of conservation.

For the verification of the ALS may be adopted methods of analysis of the DLS, defining specific limit values for cracking and deformations. However, there are situations in which the damage to the decorative setups can also occur in the absence of structural damage (e.g., fillers of considerable thickness and not sufficiently connected to the structure) or vice versa is not sensitive to this (decorations not fully constrained and therefore able to pander to cracks and structural deformations) or still, artistic assets are provided with an independent structural behaviour (pinnacles or other components that can be considered as structural appendages). In these cases they are required criteria and assessment tools specific to the ALS.

For these checks one can consider seismic actions characterized by probability of exceedance of Damage Limit State (P_{VR}= 63%) but assessed for a specific reference period for the type of asset and particularly sensitive to damage, $V_{Ra} = nV_R$ period that is obtained modifying the reference period V_R through a coefficient n, which represents the number of control cycles performed - and necessary - on the assets in a time interval that is considered useful in order to examine the state of conservation in the context of a monitoring program and control.

The innovation represented by this specification has clear implications with the concept of protection. First, there is an active action to protection by local authorities that identify the parts and the elements that need a specific assessment and declare the time required to develop controls, analysis and any maintenance. On the other side, is identified the concept - and practice - of the need for control over time of state of conservation of the assets, that is associated with the principle of planned maintenance.

In this context, the ALS is considered independent from the DLS, in fact the change of reference period leading to assume a probability of exceeding on reference period $V_R = V_N C_U$ differentiated in function of n: $P_{VR} = 1 - 0.37 \cdot {}^{1}/_{n}$. This assumption allows it to take a return time T_R greater with a corresponding seismic action most severe, in particular for the elements more susceptible to damage and the loss of which would be an irremediable damage with the methods of preservation.

4.2.The seismic vulnerability of artistic heritage. Introduction.

One of the most challenging tasks for civil society is the preservation of the artistic and cultural heritage, which must be protected against all environmental effects, both of anthropic origin, and related to exceptional phenomena such as earthquakes.

The high seismic risk and the large number of historical structures and artworks distributed over the territory make Italy a unique laboratory for the development and testing of innovative procedures for seismic vulnerability assessment of the cultural heritage. Many studies on protection forma seismic risk of cultural heritage have been produced in recent years.

A significant attention has been aimed at investigating the seismic behaviour of buildings and historical and monumental complex and about methods of restoration, to establish criteria and methods to operate interventions that are respectful of cultural values and at the same time rational and efficient.

The preservation of cultural and artistic exhibited, in particular, in the Museum is a very interesting topic. However the attention of research has always been directed more to the good "container" rather than the artwork exhibited inside it

Instead, in setting the museum should be always faced the problem of seismic risk (as well as the risks of all kinds) to which they are exposed artistic assets. In fact, the seismic risk reduction requires specific techniques and devices that must be designed according to the type objects and the seismicity of the area.

To protect the artistic assets have been developed innovative strategies that analyse both the different type of movable heritage exposed in museums and their behaviour in the event of an earthquake

4.3. Art objects classification

To identify the criteria and measures for the protection of objects of art, one must first understand the behaviour in case of earthquake. First of all a classification of artistic assets from the point of view of their mechanical behaviour is necessary [30].

The classification of artistic assets for the seismic protection aims to identify categories of objects to which it is possible to match simplified models both for the dynamic response and for the damage mechanisms more likely. This classification must respect some conditions, or:

- be characterized by very large classes ;
- also consider the type of support, that is the element on which the object is located or that constrains it, and that influences the dynamic response of the object, often significantly.

A possible classification of artistic assets is described in Tables 4.1 and 4.2 and is a new version of the one proposed in [31] later expanded from [30].

In Tables 4.3 and 4.4 the possible dynamic response and damage mechanisms are associated with each type of object and the characteristic response procedures.

Table 4.1. *Art object typological categories*

Category	*Object description*
T1	Small, flat-bottomed objects
T2	Small, not flat-bottomed objects
T3	Statues, sculptures and large vases
T4	Paintings and panels
T5	Chandeliers
T6	Others

Table 4.2. *Support/restraint in relation to categories*

	A				**B**	**C**	
	Objects supported on a flat plane				Objects	Suspended/hanging objects	
	A1	A2	A3	A4	fixed on a	C1	C2
	On the floor	On a pedestal	In display cases	On cantilever or in wall cases	flat plane or on a pedestal	Suspended on a wall	Hanging from the ceiling
T1	*	*	*	*	*	-	-
T2	*	*	*	*	*	-	-
T3	*	*	-	-	*	-	-
T4	-	-	-	-	-	*	-
T5	-	-	-	-	-	-	*
T6	*	*	*	*	*	*	*

From studies and analyses carried out by the authors, it became clear that the artistic assets had to be identified also in function of stiffness and strength and then according to the materials from which they are made. In this respect it should be noted that the values of the mechanical characteristics for resistance analysis for the various materials types are easily available in the technical literature, but to define the effective resistance of artistic assets is necessary to know the preservation state. Consequently, when it is not possible to refer to experimental tests, it is necessary to adopt subjective criteria to determine the resistance values prudently reduced.

Table 4.3. Dynamic and damages response mode for different types of artistic assets

Class	*Dynamic mode*	*Damage mode*	*Abbreviation*
A	stick motion	excessive stress	R1
	sliding motion	excessive displacement	R2
	oscillations	repeated impacts	R3
	oscillations	Overturning	R4
B	stick motion	excessive stress	R1
C	oscillations	excessive displacement	R5/R6

Table 4.4. Prevailing response mode for different types of artistic assets

Classes	*Dynamic response*
T1	R1 – R2 – R3– R4
T2	R1 – R2 – R3– R4
T3	R1 – R2 – R3– R4
T4	R5
T5	R6
T6	R1 – R2 – R3 – R4 – R5 – R6

Recently [32] was carried further classification of artistic assets on the basis of the damage observed post-earthquake. Assets are divided into two main categories: structural elements with an artistic value owing to decoration (e.g. carved stone columns); non-structural artistic elements that are somehow connected to the construction (e.g. frescos, plasters, pinnacles).

The three identified damage classes are summarized in Table 4.5.

Table 4.5. Identification of damage classes.

	Damage class	*Description*
P	Damage to artistic assets which are structural elements	This class collects damage to structural elements which have an artistic value owing to decoration are considered. The types of damage that may occur are those considered for architectonic assets.
Q	Damage to artistic assets which are not structural elements (strictly connected to structural elements)	This class collect damage to artistic assets which are not structural elements but whose behaviour is strictly dependent on the behaviour of the structural elements they are attached to. The damage here considered are all directly derived from structural damage.
R	Damage to artistic assets which are not structural element (with own seismic response)	This class collect damage to artistic assets which are not structural elements but have an own seismic response. The damage related depend on the specific behaviour of the object considered and on the connections with the supporting structure.

The above main classes are further subdivided into several sub-classes, encompassing different damage patterns and cracks morphologies which might occur while varying the type of material, shape, connection to artistic assets-structural elements, etc.
For class P the damage modes are the same considered for architectonic assets.
For class Q, the following damage modes are considered:

- *Q.a*: detachment and loss of parts. Detachment is typical of multilayer surfaces (e.g. plaster, stuccos and mosaic), it consists in the detachments of one or more layers from the support, generally leading to the loss of small portions (Figure 4.1). Loss of part may occur in non-layered artistic assets (as carved stones), in particular in jutting out elements;

Figure 4.1. Damage class *Q.a* – Detachment of mural paintings (photo by **[32]**)

- *Q.b*: cracks. In artistic assets strictly connected to the structure, it is mainly caused by the crack of the support element (Figure 4.2).

Figure 4.2. Damage class *Q.b* – Cracking (photo by **[32]**)

- *Q.c*: irreversible deformations. It refers to a loss of shape of an artistic asset that may be related to supporting structural elements deformations (Figure 4.3).

Figure 4.3. Damage class *Q.c* – Irreversible deformation (photo by **[32]**)

For class R, the following damage modes are considered:

- *R.a*: dislocation. Displacement or sliding of an artistic asset or part of it (Figure 4.4).
-

Figure 4.4. Damage class *R.a* – Dislocations (photo by **[32]**)

- *R.b*: unthreading or failure of connections. Elements not strictly connected with structures are mainly hanged, weakly connected or simply leant to structure: as a consequence, connections represent their weak points (Figure 4.5).

Figure 4.5. Damage class *R.b* – Unthreading and failure of connection. (photo by **[32]**)

- *R.c*: overturning. Elements not strictly connected with structure, as a statue or self-standing elements weakly connected, may collapse owing to the loss of equilibrium, which may derive from unthreading or failure of connections (Figure 4.6).

Figure 4.6. Damage class *R.c* – Overturning of self-standing elements (photo by **[32]**)

The classes and sub-classes of damage are summarized in Table 4.6.

Table 4.6. Damage classes

	Damage class	*Damage sub-class*
P	Damage to artistic assets which are structural elements.	Damage classes are the same of architectonic assets
Q	Damage to artistic assets which are not structural elements (strictly connected to structural elements	*Q.a*: detachment and loss of parts
		Q.b: cracks
		Q.c: irreversible deformations
R	Damage to artistic assets which are not structural element (with own seismic response)	*R.a*: dislocations
		R.b: unthreading or failure of connection
		R.c: overturning

As highlighted above, the classification of artistic assets represents a challenging task owing to their great variety. However, one of the criteria which is most adopted, in the context of the seismic vulnerability of the artistic assets, depends on their seismic behaviour, also depending on structural elements linked to. In Table 4.7 there is a list of sub-classes with their examples, for each class analysed.

Table 4.7. Classes and sub-classes of artistic assets.

Class		*Sub-class*	*Examples*
P	Artistic assets which are structural elements by themselves	*P1* – carved or shaped vertical structural assets	Caryatid, carved stone columns, walls with carved blocks or shaped bricks, …
		P2 – carved or decorated horizontal structural assets	Carved stone or wooden lintels, decorated wooden beams, …
		P3 – carved structural arched assets	Carved stone arches, vaults and domes, etc.
		P4 – carved or decorated wooden roof	Decorated wooden roof, …
Q	Artistic assets which are not structural elements (strictly connected to structural elements)	*Q1* - assets connected to vertical structural elements	Carved stone plates, frescos, mosaics, stuccoes, …
		Q2 - assets connected to the intrados of horizontal and arched structural elements	Frescos, mosaics, stuccoes, wooden or plaster false ceiling, light thin plaster vaults, …
		Q3 - assets connected to the extrados of horizontal structural elements	Floor with mosaics, decorated tiles, parquets, …
R	Artistic assets which are not structural elements (with own seismic response)	*R1* - assets leant on horizontal structural elements	Altars, sculptures, pulpits, …
		R2 - assets jutting out from vertical structural elements	Balconies, shelves, gargoyles, …
		R3 - assets hanging on horizontal structural elements	Lamps, bells, crosses, …

4.4.Static flaws of masonry structures

The building complexes are made by connected constructive membering sized so as to perform the static tasks entrusted to them, respecting the resistance characteristics of the materials used in their construction [33]. Several causes may, however, induce alterations in the regime of equilibrium of the complex requiring it new configurations with a different tensional distribution that are not always respect the limits of the material [34]. Exceeded the limits of the materials, the alterations determine some static instabilities in the masonry mass, announced by characteristic manifestations such as cracks [33]. The cracks that denounce typically the release of tensional states in the structure, are not always due to conditions of imminent danger, but simply represent the achievement of a new equilibrium configuration that can be just as effective as the previous one [34].

4.4.1. Static flaws

The failures are the outward evidence of a crisis affecting the entire building or any of its parts. These are highlighted through a series of manifestations that arise as a result of stress states that the structure is no longer able to withstand and reduce the local resistance. However, the occurrence of flaws is not strictly correlated to the static condition. It therefore seems safe to assume that a building that presents these manifestations is not in a safe condition. Since their presence is the sign of abnormal behaviour of the structure is necessary to make special investigations to determine if it is a dangerous situation and to what extent. The external signs of failures have a their way to occur, and more difficulties are found in their interpretation, since there isn't always a unique correlation between cause and effect [27].

The principle of causality in the masonry decay is regulated by a simple correspondence between failures (causes) and cracks (effects); assigned one of the two, the other is determined. This simple correspondence is not satisfied between these entities in the regressive phase because the failure, considered as the effect, is not the result of a single and determined cause, but a set of causes that intervene in their various combinations [33].

The structural instability are classified according to their direction, width and depth. Longitudinal, vertical, lateral, diagonal and generic manifestations may occur, and one can distinguish between these fractures thin, if they are distributed on the surface and occur with small relative displacements, and cracks, which are represented by the rupture of the resistant element and then are clearly visible.

A further classification of instabilities must be made between internal and external failures. The first result from structural deficiencies, the latter by soil subsidence.

Are classified as internal failures:

- settlement;
- crushing;
- combined compressive and bending stress;
- thrust;
- depression of horizontal structures;
- upsets of origin vibratory and seismic [33].

The external failures generated by settlements, uniform or differential, manifest themselves as motions of structures, which can be relative or absolute, and occur with the alteration or less of the wall system. They are:

- vertical translation;
- horizontal translation;
- rotation around a horizontal axis lying in the plane of the base bottom [33].

The rotation of a masonry wall can be caused by differential settlement of the foundation plane of the wall or from horizontal thrusts. The characteristic of these failures is that increases considerably with the increase of the height [34].

The crushing occurs when the masonry does not resist in a certain area to loads to which it is subject.

It causes a compressive stress that exceeds the capacity of resistance of the wall concerned, whose constituent materials are reduced in small parts In the case of ancient walls this phenomenon occurs when the mortars lose their cohesion or when they lose their adherence to stone materials. It can be said that one of the most frequent causes of weakening of the masonry structures is related to the degradation of the mortar due to the age [27].

Another distinction can be made between the "direct type of failures" and "indirect type of failures". The first group includes those failures involving the masonry property, and generally occur with rigid motions, deformations and cracking. The second group includes those affecting the secondary components. The two types of failures usually coexist and can denounce an irregular behaviour of the masonry structure. [27].

4.4.2. Manifestations of failures

The static instability may occur in the structures in the form of:

- rigid motions;
- cracks [27].

4.4.3. Rigid motions of the masonry

The rigid motions occur when the shape of the entire wall system is not altered, and also the distance and the orientation of the particles between them are unchanged. When the structure is affected by a relative motion, as already stated in the previous paragraph, a part of it will be altered in shape, displacement occurred then the distance and the orientation of the particles are varied. This variation can occur between particles of the portion of the factory that undergoes displacement and the one that remains in place. These elementary motions can be represented by the vector components of the translations (one vertical and two horizontal) along a triplet of Cartesian axes and rotation (around the three axes) [27].

4.4.4. Cracks

In a solid wall, the alteration of the system of elastic equilibrium, when there is not a new state of equilibrium compatible with the resistance of the whole, can cause a disturbance or a static instability that will manifest itself with a series of cracks.

The injury is defined as a perceptible and permanent interruption of the masonry. Perceptible, since it is always possible to detect it and observe it; permanent, because the process that led to its formation can never be reversed spontaneously.

The damages may appear in the form of deformations or cracks, or also of deformations and cracks coexisting in the same masonry structure [33].

One talks of deformation damages of the masonry when following the formation of abnormal stress states this is subjected to a change of geometrical shape beyond the elastic limit. This condition occurs in correspondence of a foundation settlement with the consequent relative movement between the various parts of the wall structure.
The cracking damages in the masonry structure occur with the fracture in the mass of the masonry material, namely with a relative displacement of points of the material originally continuous.
The way in which evolves the plastic deformation, the form, the evolution and extension of cracks, vary according to the type of perturbation that caused the plastic deformation or the phase of the original fracture. It follows that as each effect is related to its cause by a relationship of interdependence, the damage (effect) and the failure (cause) are always linked by a relationship extremely rigorous.
The cracks arise due to stress states that the wall structure is not able to endure and can be grouped into different classes:

- tensile crack;
- crushing cracks;
- combined compressive and bending stress cracks;
- cracks caused by arches and vaults [27].

The formation of cracks occurs in the initial stages not cracked, in a different way depending on the nature of the perturbation. Sometimes the formation of cracks is immediate, even if it is small failures, sometimes it lingers considerably, until the structural masonry is under very precarious conditions [27].

4.5.Dynamic response of artistic assets

In examining the dynamic response can be assumed an artistic assets as a rigid block resting on a rigid horizontal plan, subject to seismic action, is necessary to take into account different types of movements, considering that, under the action of external forces, the block can rest (*rest*), slide (*slide*), rotate around one of its edges (*rock*), to be affected by simultaneous sliding and rotation (*rock & slide*).
Consider a rectangular block symmetrical with respect to a vertical axis passing through the centre of gravity *G* (Figure 4.7), which is subjected, in addition to its own weight, to an horizontal and a vertical excitation: to Coulomb's law the maximum force

of static friction (dynamic) *f* can be calculated by multiplying the vertical reaction at the base *N* for the coefficient of static friction (dynamic).

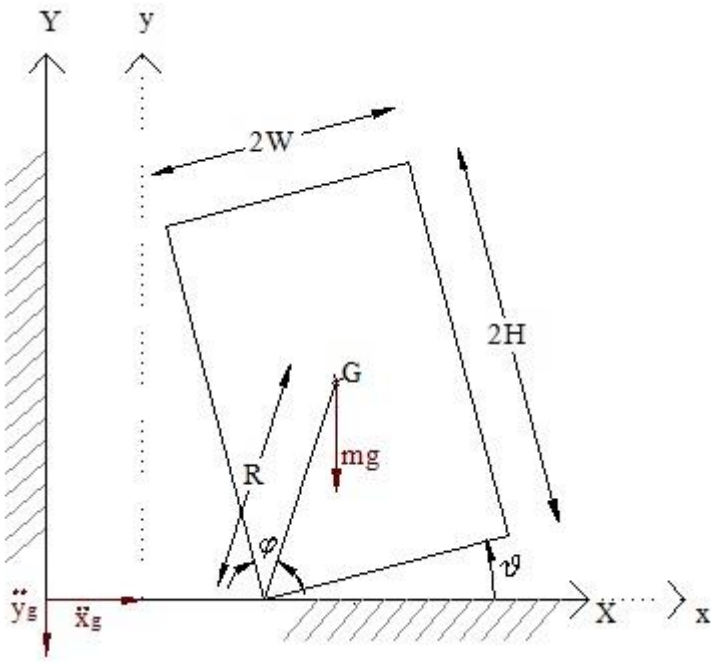


Figure 4.7. Rigid block model

It is assumed that the block is not anchored to the foundation, $\ddot{x}_g$ is the horizontal acceleration (assumed positive if directed from right to left) while $\ddot{y}_g$ is the vertical acceleration (assumed positive if facing down), imprinted on the ground in generic instant of time. Order that the block remains in the condition of *rest*, the force of friction to the base must not reach the value of the maximum static friction force, that is:

$$|f| = m|\ddot{x}| = m|\ddot{x}_g| < \mu_S N \qquad (4.2)$$

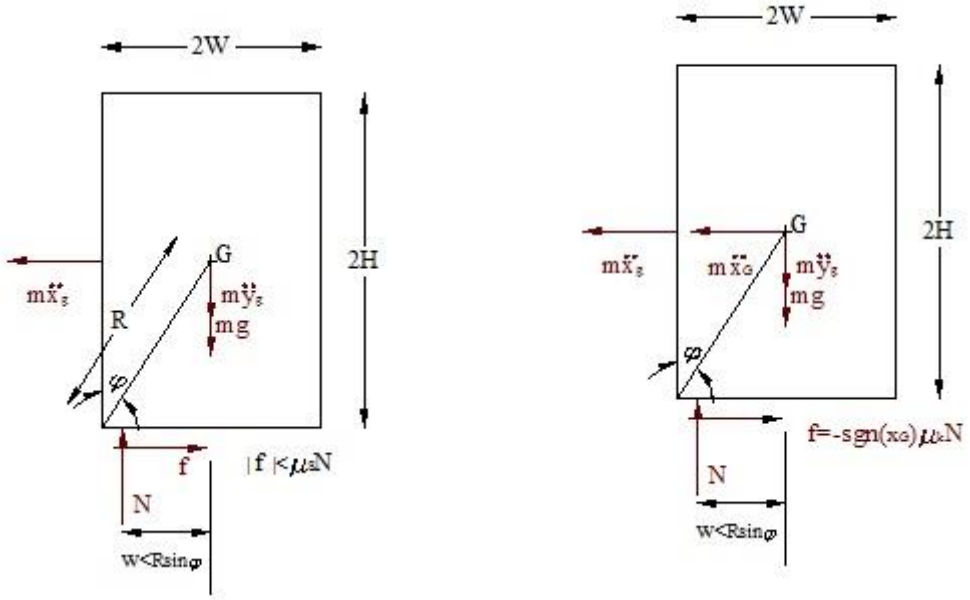
where $\ddot{x}$ is the absolute acceleration of the system, coincident to that of the soil, until the block remains stationary, μ_S is the coefficient of static friction, *m* is the mass of the block and *N* is the vertical reaction at the base.

Being, for the vertical equilibrium of forces:

$$N = mg + m\ddot{y}_g \qquad (4.3)$$

with *g* the acceleration of gravity, the condition of *non-sliding* is written (Figure 4.8):

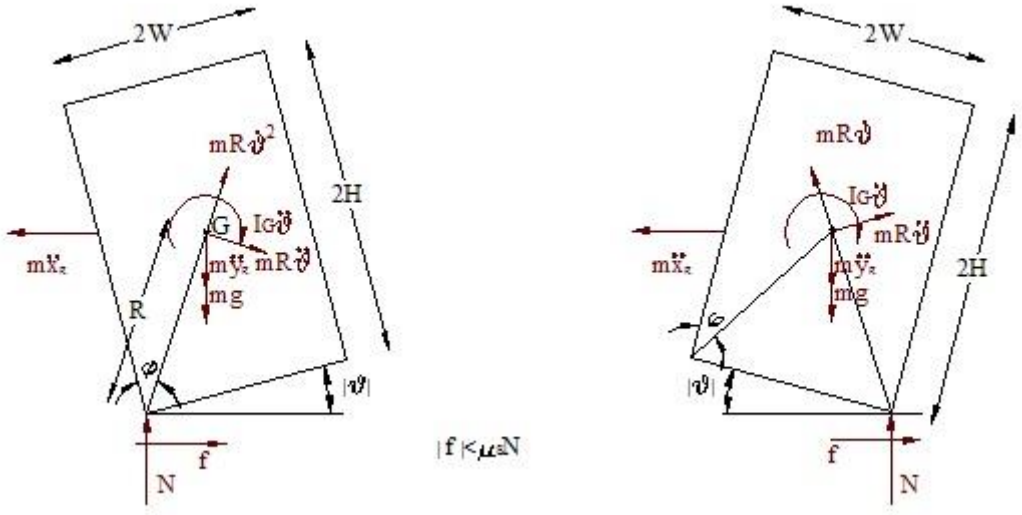
$$|\ddot{x}_g| < \mu_S g + \mu_S \ddot{y}_g \qquad (4.4)$$



Rest condition *Sliding condition*

Figure 4.8

The vertical reaction *N* passing through the centre of rotation (Figure 4.9), in the instant of transition from the *rest* to the *rocking* around one of the two vertices.



Rocking condition: $\vartheta > 0$ *Rocking condition:* $\vartheta < 0$

Figure 4.9

Therefore, denoting by *R* the "size", defined as the distance between the centroid of the block and the centre of rotation, and with φ the angle between the vertical axis and the

diagonal of the block, the condition of *non-rocking* writing imposing that the overturning moment around the centre of mass of the block is less than the stabilizer:

$$|f|R\cos\varphi < NR\sin\varphi \tag{4.5}$$

which becomes, substituting the values of f and N derived from the equations of equilibrium horizontal and vertical $\left(f = m\ddot{x}_g; N = m\ddot{y}_g + mg\right)$:

$$\ddot{x}_g < \left(\ddot{y}_g + g\right)\tan\varphi \tag{4.6}$$

The activation conditions of the various types of motion examined can be summarized as follows:

TYPE OF MOTION	HORIZONTAL DIFFERENCE	VERTICAL DIFFERENCE	DIFFERENCE OF MOMENTS
REST	$\ddot{y}_g + g > 0$	$\lvert\ddot{x}_g\rvert < \mu_s\ddot{y}_g + \mu_s g$	$\lvert\ddot{x}_g\rvert < \tan\varphi\ddot{y}_g + \tan\varphi g$
ROCKING	$\ddot{y}_g + g > 0$	$\lvert\ddot{x}_g\rvert < \mu_s\ddot{y}_g + \mu_s g$	$\lvert\ddot{x}_g\rvert = \tan\varphi\ddot{y}_g + \tan\varphi g$
SLIDING	$\ddot{y}_g + g > 0$	$\lvert\ddot{x}_g\rvert = \mu_s\ddot{y}_g + \mu_s g$	$\lvert\ddot{x}_g\rvert < \tan\varphi\ddot{y}_g + \tan\varphi g$
ROCKING AND SLIDING	$\ddot{y}_g + g > 0$	$\lvert\ddot{x}_g\rvert = \mu_s\ddot{y}_g + \mu_s g$	$\lvert\ddot{x}_g\rvert = \tan\varphi\ddot{y}_g + \tan\varphi g$

The condition $\ddot{y}_g + g > 0$ is therefore a prerequisite both for the *rest*, that for the *sliding* and *rocking*.

In conclusion the behaviour of the block is defined by two parameters $\tan\varphi$ and μ_s, in other words by the geometry and the material, insofar if $\tan\varphi < \mu_s$ from the condition of *rest* is passed to that of *rocking*, if $\tan\varphi > \mu_s$ from the condition of *rest* is passed to that of *sliding*, and finally if $\tan\varphi = \mu_s$ from the condition of *rest* is passed to that of *rocking & sliding*.

4.5.1. Sliding conditions.

The block begins to slide, under the effect of seismic excitation, when occurs the condition:

$$\lvert\ddot{x}_g\rvert = \mu_s\ddot{y}_g + \mu_s g \tag{4.8}$$

while *(4.6)* and *(4.7)* continue to be verified. In conclusion, therefore, the horizontal force of inertia exceeds the frictional force, while the resulting vertical force of gravity and vertical excitation has the direction of the force of gravity, so that the overturning moment, generated by the excitement at the base, does not exceed that stabilizing, therefore one can be exclude the *rocking* block.

4.5.2. Graphical representation of the types of motion.

Can be assumed that the vertical acceleration is proportional, by a factor k variable in a range *[0, 1]*, to the horizontal acceleration:

$$\ddot{y}_g = k\ddot{x}_g \tag{4.9}$$

in this way, then, by calculating:

$$\frac{|\ddot{x}_g|}{g+\ddot{y}_g} = \frac{|\ddot{x}_g|}{g+k\ddot{x}_g} = \frac{1}{\frac{g}{|\ddot{x}_g|}+k\frac{\ddot{x}_g}{|\ddot{x}_g|}} = \frac{1}{\frac{g}{|\ddot{x}_g|}+k\,\mathrm{sgn}(\ddot{y}_g)} \tag{4.10}$$

Where:

$\mathrm{sgn}(\ddot{y}_g) = +1$ ... per $\ddot{y}_g > 0$; $\mathrm{sgn}(\ddot{y}_g) = -1$ ... per $\ddot{y}_g < 0$;

is obtained the expression of two constants:

$$a = \frac{1}{\frac{g}{|\ddot{x}_g|}+k} \text{ quando } \ddot{y}_g > 0; \tag{4.11}$$

$$a = \frac{1}{\frac{g}{|\ddot{x}_g|}-k} \text{ quando } \ddot{y}_g < 0; \tag{4.12}$$

It is possible then relate these two constants, the coefficient of static friction μ_s and the quantity geometric $\tan\varphi$, with the possible movements of the rigid block, *sliding* and *rocking*.

In fact, the conditions of *sliding* can be written:

$$\mu_s(g+\ddot{y}_g) \le |\ddot{x}_g| \le \tan\varphi(g+\ddot{y}_g) \Rightarrow \mu_s \le \frac{|\ddot{x}_g|}{g+\ddot{y}_g} \le \tan\varphi \tag{4.13}$$

which implies that the prerequisite for the *sliding*, which corresponds to the square area in Figure 4.4, is:

$$\mu_s \le \tan\varphi \tag{4.14}$$

Combining equations (4.9), (4.10) and (4.11) is obtained:

$$\mu_s \le a \le \tan\varphi \text{ quando } \ddot{y}_g > 0 \tag{4.15}$$

$$\mu_s \leq c \leq \tan\varphi \text{ quando } \ddot{y}_g < 0 \qquad (4.16)$$

that result in the textured area in Figure 4.10, that is the area of pure *sliding*.
The areas belonging to the *rocking* can be derived in a similar way.

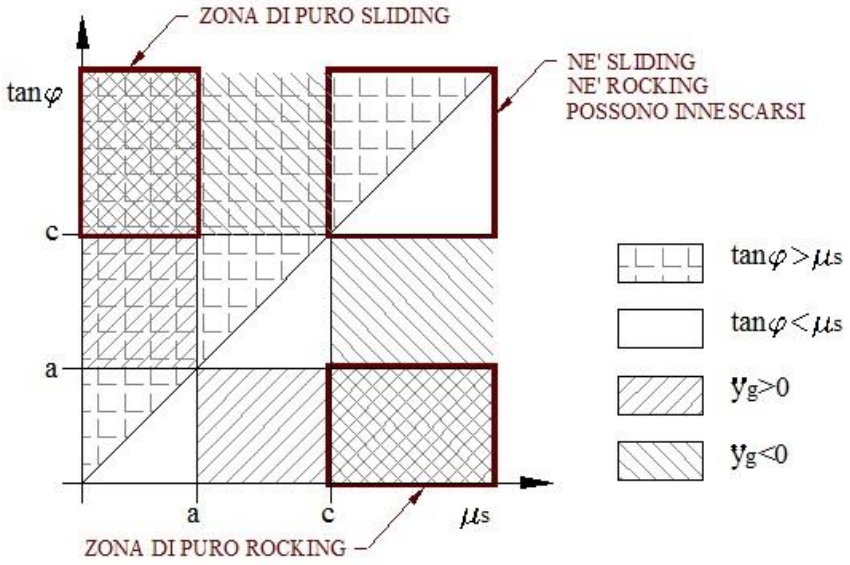


Figure 4.10

It is interesting to observe that, when both μ_s that $\tan\varphi$ are smaller than *a*, the horizontal inertia force exceeds the value of the force of static friction and simultaneously the overturning moment exceeds the restoring moment, in other words we are in the presence of *rocking & sliding*. Similarly, when both μ_s that $\tan\varphi$ are larger than *c*, the horizontal inertia force does not exceed the value of the force of static friction and simultaneously the overturning moment is not able to win the restoring moment, for which the block remains in *rest*.
While $\ddot{y}_g = 0$ gives the situation shown in Figure 4.11.

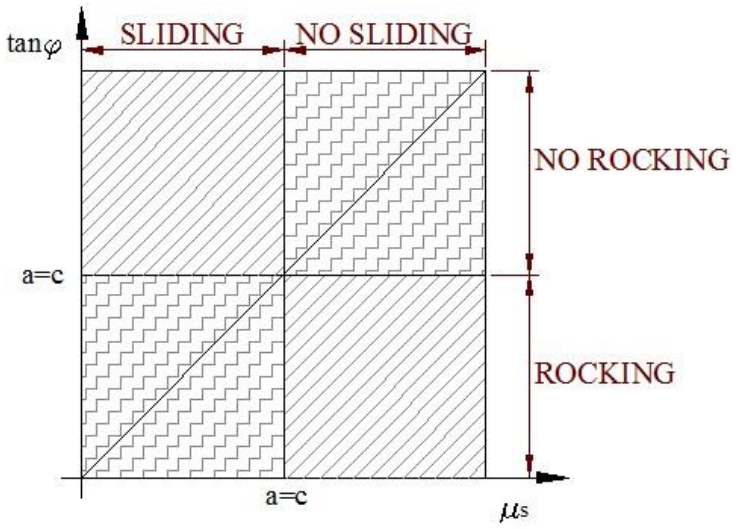


Figure 4.11

4.5.3. Sliding equation.

During *sliding*, the equilibrium condition of forces in the two directions, as evidenced from reading the Figure 4.8, can be written:

$$f = m(\ddot{x}_g + \ddot{x}_G) \qquad N = m(\ddot{y}_g + g) \qquad (4.17\ a, b)$$

where $\ddot{x}_G$ is the relative acceleration of the block in the generic instant.

Moreover, the dynamic frictional force, opposite to the motion by definition, is:

$$f = -\text{sgn}(\dot{x}_G)\mu_k N \qquad (4.18)$$

where $\text{sgn}(x_G)$ represents the sign of the relative speed of the block and μ_k the coefficient of dynamic friction.

The substitution of (4.17a) and (4.17b) in (4.18) gives the equation of motion of the block relative to the *sliding*, which rewritten becomes:

$$m\ddot{x}_G + m\frac{\dot{x}_G}{|\dot{x}_G|}\mu_k(\ddot{y}_g + g) = -m\ddot{x}_g \qquad (4.19)$$

and finally, simplifying:

$$\ddot{x}_G + \frac{\dot{x}_G}{|\dot{x}_G|}\mu_k(\ddot{y}_g + g) = -\ddot{x}_g \qquad (4.20)$$

Applying the method of integration of Newmark, the recursive equations for the calculation of displacement, velocity and acceleration on the block are written in this case:

$$\left[\frac{1}{\beta\Delta t^2} + \frac{\gamma}{\beta\Delta t}\frac{\mu_k(\ddot{y}_g+g)}{|\ddot{x}_G|}\right]x_G^{t+\Delta t} = -\ddot{x}_g^t + \frac{1}{\beta\Delta t^2}x_G^t + \frac{1}{\beta\Delta t}\dot{x}_G^t + \qquad (4.21)$$

$$\left(\frac{1}{2\beta}-1\right)\ddot{x}_G^t+\frac{\mu_k(\ddot{y}_g+g)}{|\dot{x}_G|}\left[\frac{\gamma}{\beta\Delta t}x_G^t+\left(\frac{\gamma}{\beta}-1\right)\dot{x}_G+\frac{\Delta t}{2}\left(\frac{\gamma}{\beta}-2\right)\ddot{x}_G^t\right]$$

$$\ddot{x}_G^{t+\Delta t}=\frac{1}{\beta\Delta t^2}\left(x_G^{t+\Delta t}-x_G^t\right)-\frac{1}{\beta\Delta t}\dot{x}_G^t-\left(\frac{1}{2\beta}-1\right)\ddot{x}_G^t \tag{4.22}$$

$$\dot{x}_G^{t+\Delta t}=\left(1-\frac{\gamma}{\beta}\right)\dot{x}_G^t+\frac{\gamma}{\beta\Delta t}\left(x_G^{t+\Delta t}-x_G^t\right)-\left(\frac{\gamma\Delta t}{2\beta}-\Delta t\right)\ddot{x}_G^t \tag{4.23}$$

where the values $\beta = 0.25$ and $\gamma = 0.5$ are used to make the algorithm unconditionally stable.

In order that the block remains in a condition of *non-rocking* must be verified at every instant the equation (4.5), with the value of the dynamic friction force provided by (4.18). By making this replacement is reached the condition:

$$\mu_k < \tan\varphi \tag{4.24}$$

The respect of this condition is normally guaranteed by the fact that $\mu_k < \mu_s$, and being, as an activation condition of *sliding*, $\mu_s < \tan\varphi$, it can be deduced that there is the possibility that the physical condition of *sliding* evolve in the *rocking*, while it will be possible to evolve in the *rest*. In fact, the block stops in the instant of time when is cancelled its relative speed and, in particular, if at that moment are automatically verified the activation conditions of *sliding*, will resume immediately to slide changing direction, conversely will remain in the state of *rest* as long as these conditions are not be recovered, consistently with the features of the seismic excitation and friction at the base.

4.5.4. Rocking conditions.

The block begins to rotate around one of the base edges, under the effect of seismic excitation, when occurs the condition:

$$\left|\ddot{x}_g\right| = \tan\varphi\ddot{y}_g + \tan\varphi\, g \tag{4.25}$$

while (4.4) and (4.7) continue to be verified.

In conclusion, therefore, the overturning moment, generated by the excitement at the base, exceeds the stabilizer, while the resultant of vertical gravity force and vertical excitation has the direction of the force of gravity and the horizontal force of inertia does not exceed the friction force, so that can be excluded the *sliding* block.

4.5.5. Rocking equation.

During *rocking*, the equilibrium condition to the translation of the horizontal forces, as can be observed in Figure 4.9, is written as:

$$f = m\left[\ddot{x}_g - R\ddot{\theta}\cos(\varphi - |\theta|) - \text{sgn}(\theta)R\dot{\theta}^2\sin(\varphi - |\theta|)\right] \quad (4.26)$$

The equilibrium to the vertical translation provides, however:

$$N - mg = mR\left[\text{sgn}(\theta)\ddot{\theta}\sin(\varphi - |\theta|) - \dot{\theta}^2\cos(\varphi - |\theta|)\right] \quad (4.27)$$

Finally the equilibrium to the rotation around the centre of mass *G*:

$$fR\cos(\varphi - |\theta|) - \text{sgn}(\theta)NR\sin(\varphi - |\theta|) = I_G\ddot{\theta} \quad (4.28)$$

where I_G is the moment of inertia of the block with respect to *G*, which in the case considered is equal to:

$$I_G = \frac{mR^2}{3} \quad (4.29)$$

Substituting equations (4.26) and (4.27) in the (4.28) is obtained:

$$\begin{aligned} &m\ddot{x}_g R\cos(\varphi - |\theta|) - mR^2\ddot{\theta}\cos^2(\varphi - |\theta|) - \\ &m\text{sgn}(\theta)R\dot{\theta}^2\sin(\varphi - |\theta|)\,R\cos(\varphi - |\theta|) - \text{sgn}(\theta)R\sin(\varphi - \\ &|\theta|)\,mg - \text{sgn}(\theta)R\sin^2(\varphi - |\theta|)mR\text{sgn}(\theta)\ddot{\theta} + \\ &\text{sgn}(\theta)R\sin(\varphi - |\theta|)\,mR\dot{\theta}^2\cos(\varphi - |\theta|) = I_G\ddot{\theta} \end{aligned} \quad (4.30)$$

Making the appropriate simplifications and setting:

$$I_O = I_G + mR^2 = \frac{4}{3}mR^2 \quad (4.31)$$

it leads to the equation of motion for the *rocking*:

$$\text{sgn}(\theta)mgR\sin(\varphi - |\theta|) - m\ddot{x}_g R\cos(\varphi - |\theta|) + I_O\ddot{\theta} = 0 \quad (4.32)$$

For the resolution of this equation is still using the Newmark method, thus involving the use of the recursive formulas for the acceleration and the angular velocity:

$$\ddot{\theta}^t = \frac{1}{\beta\Delta t^2}\left(\theta^{t+\Delta t} - \theta^t\right) - \frac{1}{\beta\Delta t}\dot{\theta}^t - \left(\frac{1}{2\beta} - 1\right)\ddot{\theta}^t \quad (4.33)$$

$$\dot{\theta}^{t+\Delta t} = \left(1 - \frac{\gamma}{\beta}\right)\dot{\theta}^t + \frac{\gamma}{\beta\Delta t}\left(\theta^{t+\Delta t} - \theta^t\right) - \left(\frac{\gamma\Delta t}{2\beta} - \Delta t\right)\ddot{\theta}^t \quad (4.34)$$

Substituting the expression of $\ddot{\theta}^{t+\Delta t}$ into equation (4.32) written at time $t + \Delta t$, is obtained an equation in θ which can be solved by trial and error, not being linear.

It may be noted that in the case of $(\varphi - |\theta|) \ll 0$ the equation can be simplified trough the hypothesis of small displacements, by placing:

$$\sin(\varphi - |\theta|) \cong \tan(\varphi - \theta) \cong (\varphi - \theta); \cos(\varphi - \theta) \cong 1 \qquad (4.35)$$

In conclusion the more the block is slender the more it can be considered valid the assumption of small displacements.

4.5.6. Sliding & rocking.

This particular mode of motion may be activated both from a condition of *rest*, that during the *rocking* (Figure 4.12).

In the first case it is necessary to occur simultaneously:

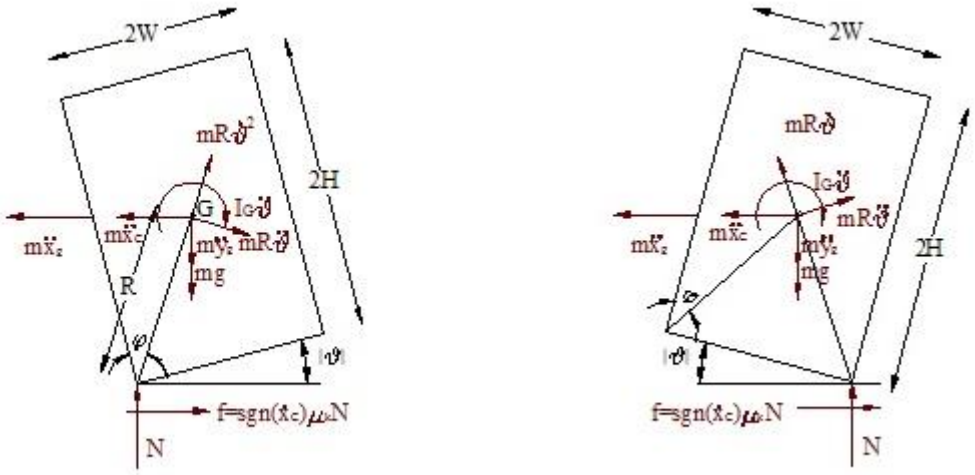
$$|\ddot{x}_g| = \mu_s g \; ; \; |\ddot{x}_g| = \tan\varphi g \qquad (4.36)$$

in other words that the activation conditions of the *sliding* will occur simultaneously in the activation of the *rocking*.

In the second case, instead, must be:

$$f < \mu_s N \qquad (4.37)$$

with *f* and *N* provided by (4.26) and (4.27).



Rocking & sliding conditions: $\vartheta > 0$ *Rocking & sliding conditions:* $\vartheta < 0$

Figure 4.12

Writing then the equilibrium equation to rotation around the centre of gravity *G*, during the *rocking* of the block, is obtained:

$$fR\cos(\varphi - |\theta|) - \mathrm{sgn}(\theta)NR\sin(\varphi - |\theta|) = I_G\ddot{\theta} \qquad (4.38)$$

Considering, however, the equilibrium of the structure along the horizontal direction, the force of friction (dynamic) takes the form:

$$f = m\left[\ddot{x}_g + \ddot{x}_c - R\ddot{\theta}\cos(\varphi - |\theta|) - \text{sgn}(\theta)R\dot{\theta}^2\sin(\varphi - |\theta|)\right] \quad (4.39)$$

where $\ddot{x}_c$ represents the acceleration at the corner around which the rotation is performed.

The writing of equilibrium to the vertical translation, however, reproduces identically the equation (4.27).

So that can be realized the *sliding*, in conjunction with the *rocking*, the condition will occur:

$$f = -\text{sgn}(\dot{x}_c)\mu_k N \quad (4.40)$$

Substituting the equation (4.39) and (4.27) in (4:40) is obtained the equation of motion relative to the *sliding*:

$$-\text{sgn}(\dot{x}_c)\mu_c\left[g + \text{sgn}(\theta)R\ddot{\theta}\sin(\varphi - |\theta|) - R\dot{\theta}^2 R\cos(\varphi - |\theta|)\right] = \ddot{x}_g + \ddot{x}_c - \text{sgn}(\theta)R\dot{\theta}^2\sin(\varphi - |\theta|) - R\ddot{\theta}\cos(\varphi - |\theta|) \quad (4.41)$$

Still, by substituting the expressions of f and N given by (4.39) and (4.27) in (4:38), is obtained the equation of motion relative to the *rocking*:

$$\left\{\frac{I_G}{m} + R^2\sin^2(\varphi - |\theta|) + \frac{1}{2}\text{sgn}(\dot{x}_c)\text{sgn}(\theta)\mu_k R^2\sin[2(\varphi - |\theta|)]\right\}\ddot{\theta} - \left\{\text{sgn}(\dot{x}_c)\mu_k R^2\cos^2(\varphi - |\theta|) + \frac{1}{2}\text{sgn}(\theta)R^2\sin[2(\varphi - |\theta|)]\right\}\dot{\theta}^2 + [\text{sgn}(\dot{x}_c)\mu_k R\cos(\varphi - |\theta|) + \text{sgn}(\theta)R\sin(\varphi - |\theta|)]g = 0 \quad (4.42)$$

In the instant when $\dot{x}_c = 0$, one has the transition to pure *rocking*: this depends on the values of $\ddot{x}_g$ and μ_s.

Assuming small displacements hypothesis, valid in the case of slender block, for which $(\varphi - |\theta|) \ll 0$, the (4.35) can be considered valid, but the terms in $\dot{\theta}^2$ can be neglected, so that the (4.41) and (4.42) can be linearized in the following way:

$$-\text{sgn}(\dot{x}_c)\mu_k\left[g + sgn(\theta)R\ddot{\theta}(\varphi - |\theta|)\right] = \ddot{x}_g + \ddot{x}_c - R\ddot{\theta} \quad (4.43)$$

$$\left\{\frac{I_G}{m} + R^2(\varphi - |\theta|)^2 + \text{sgn}(\dot{x}_c)\text{sgn}(\theta)\mu_k R^2(\varphi - |\theta|)\right\}\ddot{\theta} + [\text{sgn}(\dot{x}_c)\mu_k R + \text{sgn}(\theta)R(\varphi - |\theta|)]g = 0 \quad (4.44)$$

4.5.7. Impact between the rigid block and support.

During the rock block impacts with the support and loses energy.

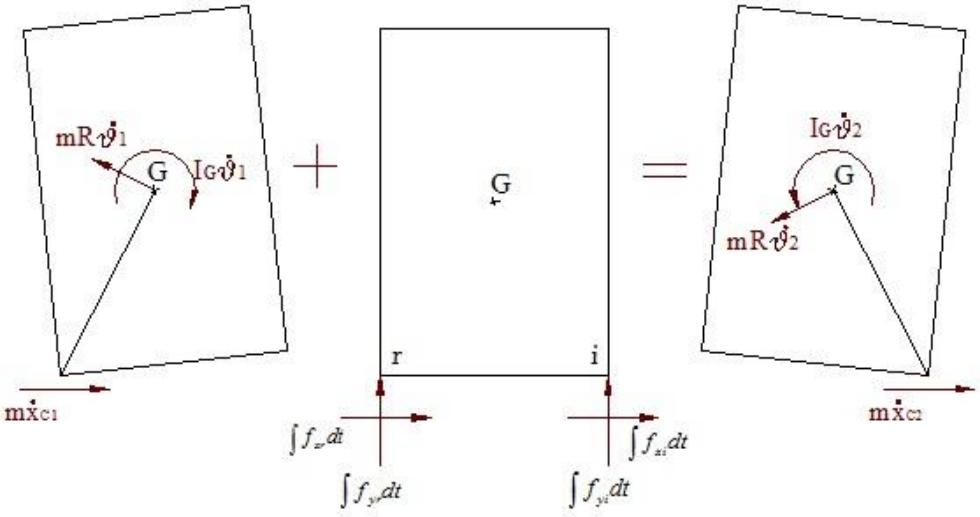
According to the classical theory of the impact, it can be assumed that the phenomenon is such that, while the block is oscillating around an extreme point, impacts with the support on the other end without considering intermediate positions. Furthermore it is assumed that there is no bounce at impact, which means that is excluded the possibility that the coefficient of restitution is negative.

In this sense, the block cannot impacting on the same corner.

In some cases, a change of type of motion between before and after the impact is possible, in dependence on the values taken by the pulses agents at the corners, which can be written, in the two directions, $\int f_x dt$ and $\int f_y dt$.

Being small the duration of the impact and the speeds discontinuous, the accelerations and the impulsive forces can be considered preponderant in relation to the weight of the block. For this reason, in the classical theory of the impact, usually are neglected the gravitational effects.

To arrive at the analytical formulation of the impact, may be considered the impulses which is subject to the block in the moments immediately before and after impact ($\theta = 0$), shown in Figure 4.13.



Impact diagram for $\vartheta < 0$

Figure 4.13

The equilibrium to the translation along the x direction provides:

$$-mR\dot{\theta}_1 \cos\varphi + m\dot{x}_{c1} + \int f_{xi}dt + \int f_{xr}dt = -mR\dot{\theta}_2 \cos\varphi + m\dot{x}_{c2} \tag{4.45}$$

The equilibrium to the translation along the y direction provides:

$$-\text{sgn}(\dot{\theta}_1)mR\dot{\theta}_1 \sin\varphi + \int f_{yi}dt + \int f_{yr}dt = \text{sgn}(\dot{\theta}_2)mR\dot{\theta}_2 \sin\varphi \tag{4.46}$$

The equilibrium to the rotation around the centre of gravity provides:

$$I_G\dot{\theta}_1 + [\int f_{xi}dt + \int f_{xr}dt]R\cos\varphi + \text{sgn}(\dot{\theta}_1)[\int f_{yr}dt - \int f_{yi}dt]R\sin\varphi = I_G\dot{\theta}_2 \tag{4.47}$$

where the subscripts *i* and *r* respectively indicate the edge where impacts and the one around which it rotates the block.

In such a situation the conditions for the block remains in the *non-sliding* mode or evolves in *sliding* is written:

$$\left|\int f_{xi}dt + \int f_{xr}dt\right| \leq \mu_s \left|\int f_{yr}dt + \int f_{yi}dt\right| \tag{4.48}$$

$$\left|\int f_{xi}dt + \int f_{xr}dt\right| = -\mu_s \text{sgn}(\dot{x}_{c2}) \left|\int f_{yr}dt + \int f_{yi}dt\right| \tag{4.49}$$

It introduces the pulse resulting in the x direction, equal to:

$$\int f_x dt = \int f_{xi}dt + \int f_{xr}dt \tag{4.50}$$

In conclusion there are two different situations. When the block remains in the condition of *non-sliding* after the impact, the terms in $\dot{x}_{c2}$ can be eliminated, then the equations simplified. In this situation the unknowns of the problem are four $\left(\int f_x dt;\ \int f_{yi}dt\,;\ \int f_{yr}dt\,;\ \dot{\theta}_2\right)$, against three equations ((4.45); (4.46); (4.47), simplified).

When, instead the block continues to slide after the impact the unknowns become five (adding also$\dot{x}_{c2}$), against four equations ((4.45) (4.46) (4.47) (4.49)).

Ultimately, it is necessary to add, in each case, a further condition to solve analytically the problem. It is reasonable, in fact, assume $\int f_{yr}dt \ll \int f_{yi}dt$, then delete the terms in the equations in $\int f_{yr}dt$, and also reduce the number of unknowns.

4.5.8. Derivation of the impact equations.

The two the conditions described above can be examined separately.

In the first case the simplified equations are rewritten, putting s $sgn(\dot{\theta}_1) = sgn(\dot{\theta}_2)$:

$$-mR\dot{\theta}_1\cos\varphi + m\dot{x}_{c1} + \int f_x dt = -mR\dot{\theta}_2\cos\varphi \tag{4.51}$$

$$-mR\dot{\theta}_1 \sin\varphi + \int f_{yi}dt = mR\dot{\theta}_2 \sin\varphi \tag{4.52}$$

$$I_G\dot{\theta}_1 + \left(\int f_x dt\right) R\cos\varphi + \mathrm{sgn}(\dot{\theta}_1)\left(\int f_{yi}dt\right) R\sin\varphi = I_G\dot{\theta}_2 \tag{4.53}$$

Substituting (4.51) and (4.52) in (4.53) is obtained, for $\dot{\theta}_1 < 0$:

$$\begin{aligned} &I_G\dot{\theta}_1 - mR^2\theta_2\cos^2\varphi + mR^2\dot{\theta}_1\cos^2\varphi - \dot{x}_{c1}mR\cos\varphi - \\ &mR^2\dot{\theta}_2\sin^2\varphi - mR^2\dot{\theta}_1\sin^2\varphi = I_G\dot{\theta}_1 - \dot{x}_{c1}mR\cos\varphi - \\ &mR^2\dot{\theta}_2 + mR^2\dot{\theta}_1(1-\sin^2\varphi) - mR^2\dot{\theta}_1\sin^2\varphi = I_G\dot{\theta}_1 \Rightarrow \\ &\dot{\theta}_2(I_G + mR^2) = \dot{\theta}_1(I_G + mR^2) - 2mR^2\dot{\theta}_1\sin^2\varphi - \\ &\dot{x}_{c1}mR\cos\varphi \Rightarrow \dot{\theta}_2 = \dot{\theta}_1 - \frac{\left(2mR^2\dot{\theta}_1\sin^2\varphi + \dot{x}_{c1}mR\cos\varphi\right)}{I_O} \end{aligned} \tag{4.54}$$

Based on the results obtained, the condition of *non-sliding* becomes:

$$\mu_S \geq \frac{\left|\int f_x dt\right|}{\left|\int f_{yi}dt\right|} = \frac{\left|mR\cos\varphi\left(\dot{\theta}_1 - \dot{\theta}_2\right) - m\dot{x}_{c1}\right|}{\left|mR\sin\varphi\left(\dot{\theta}_1 + \dot{\theta}_2\right)\right|} \tag{4.55}$$

that, through appropriate processing, is transformed into:

$$\mu_s \geq \frac{\left|(e_1 + e_2)\,H/W\right|}{|1 + e_1|} \tag{4.56}$$

where:

$$\begin{aligned} e_2 &= \frac{\dot{x}_{C1}}{H\dot{\theta}_1} \ \text{ con } \ \dot{x}_{G1} = \dot{x}_{c1} - R\dot{\theta}_1\cos\varphi \\ e_1 &= 1 - \frac{3}{4}(1+e_2)\cos^2\varphi - \frac{3}{2}\sin^2\varphi \end{aligned} \tag{4.57}$$

In the second case, however, when the block starts to slide after the impact, the condition (4.49) becomes:

$$\int f_x dt = -\mu_k \mathrm{sgn}(\dot{x}_{c2})mR\left(\dot{\theta}_1 + \dot{\theta}_2\right)\mathrm{sgn}\left(\dot{\theta}_1\right)\sin\varphi \tag{4.58}$$

In conclusion, substituting the expressions of $\int f_x dt$ and $\int f_{yi}dt$ in equation to the rotation around *G*, is reached a relationship that can be summarized as follows:

$$\dot{\theta}_2 = e\dot{\theta}_1 \tag{4.59}$$

where the coefficient of restitution for the angular velocities *e*, is equal to:

$$e = \frac{I_G - \mathrm{sgn}\left(\dot{\theta}_1\right)\mu_k\mathrm{sgn}(\dot{x}_{c2})mR^2\sin\varphi\cos\varphi - mR^2\sin^2\varphi}{I_G + \mathrm{sgn}\left(\dot{\theta}_1\right)\mu_k\mathrm{sgn}(\dot{x}_{c2})mR^2\sin\varphi\cos\varphi + mR^2\sin^2\varphi} \tag{4.60}$$

In terms of energy, being $\theta = 0$ in correspondence of the impact, the potential energy is zero, then all of the total energy is in the form of kinetic energy. The ratio between the amount of kinetic energy before and after the impact, is equal to:

$$r = \frac{\frac{1}{2} I_O \dot{\theta}_2^2}{\frac{1}{2} I_O \dot{\theta}_1^2} = \frac{\dot{\theta}_2^2}{\dot{\theta}_1^2} = e^2 \tag{4.61}$$

then the lost energy during the impact $1 - r = 1 - e^2$and is inversely proportional to the coefficient of restitution.

Finally rewriting the equilibrium equation in the x direction on the basis of the results obtained, one has:

$$\dot{x}_{c2} = R\left[(e-1)\cos\varphi - (e+1)\mathrm{sgn}(\dot{\theta}_1)\mu_k \mathrm{sgn}(\dot{x}_{c2})\sin\varphi\right]\dot{\theta}_1 + \dot{x}_{c1} \tag{4.62}$$

As can be seen from equation (4.62), to evaluate the coefficient of restitution is first necessary to know the sign of $\dot{x}_{c2}$. Moreover, even in the equation of $\dot{x}_{c2}$ appears $\mathrm{sgn}(\dot{x}_{c2})$. To overcome this disadvantage one can proceed by setting the sign of $\dot{x}_{c2}$, then move to the calculation of e and $\dot{x}_{c2}$. If the sign of $\dot{x}_{c2}$ confirms the prediction, the result is right, conversely the sign of $\dot{x}_{c2}$ must be changed and repeat the procedure.

The analytical formulation of the impact, until now illustrated, allows to know the angular velocity which is subjected the block, assuming that the duration of the impact is so low that one can assume that the position of the block remains the same after the impact.

It should however be noted that it is not so easy to determine the acceleration of the block after the impact.

It is a problem little documented in the literature: some propose to determine the acceleration following the approach of Newmark, in other words, deriving it from the values of the quantities involved before impact. This solution may seem, however, inadequate, insofar as the procedure Newmark can be applied only to problems that are continuous in response, while, in correspondence of the impact, the phenomenon presents a discontinuity.

Alternatively may be applied Newton's second law, which remains valid for the block at each instant, including the one immediately before impact.

To end the impact theory, can be considered the simplified case of pure *rocking* motion.

In this case, cancelling all terms in $\dot{x}_{c1}$, the (4:53) becomes:

$$\dot{\theta}_2 = \frac{\dot{\theta}_1(I_O - 2mWR\sin\varphi)}{I_O} \tag{4.63}$$

while the *non-sliding* condition, becomes:

$$\mu_s \geq \frac{3\sin\varphi\cos\varphi}{1+3\cos^2\varphi} \tag{4.64}$$

and is dependent only on the geometry of the block.

In this situation, moreover, the coefficient of restitution takes the form:

$$e = \frac{\dot{\theta}_2}{\dot{\theta}_1} = 1 - \frac{mR^2\sin^2\varphi}{\frac{4}{3}mR^2} = 1 - \frac{3}{2}\sin^2\varphi \tag{4.65}$$

and can be plotted as a function of the slenderness ratio of the block $\frac{H}{W} = \arctan^{-1}\varphi$, as in Figure 4.14.

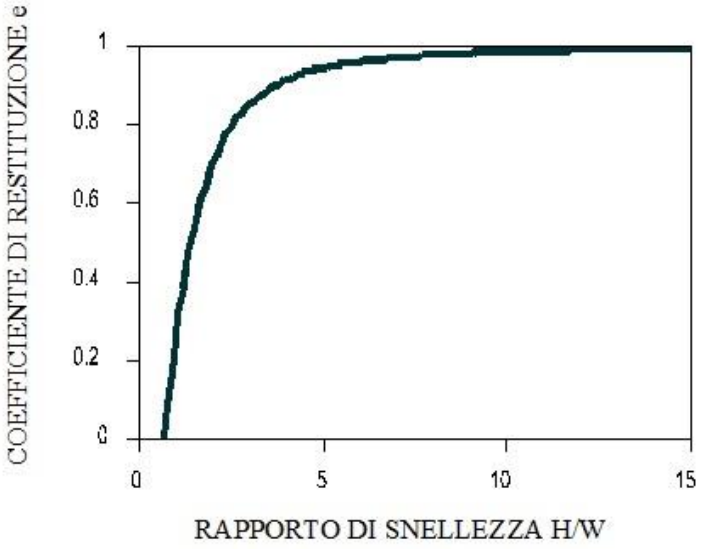


Figure 4.14

In conclusion the coefficient of restitution becomes zero when the slenderness ratio $\frac{H}{W} = \frac{1}{\sqrt{2}}$, and tends to 1 when $\frac{H}{W} \Rightarrow \infty$.

For $\frac{H}{W} < \frac{1}{\sqrt{2}}$, e assumes negative values, that is, the angular velocity changes sign after the impact, which indicates that the block is rebounded.

The condition for the transition from *rest* to pure *rocking* is$\mu_s > \tan\varphi$. Therefore the equation suggests that if $\mu_s < \frac{3\sin\varphi\cos\varphi}{1+3\cos^2\varphi}$, the block evolves into a condition of *rocking & sliding* after the impact. In fact, since:

$$\frac{3\sin\varphi\cos\varphi}{1+3\cos^2\varphi}=\frac{3\cos^2\varphi}{1+3\cos^2\varphi}\tan\varphi\leq\tan\varphi \tag{4.66}$$

will never occur physically the possibility that, due to the impact, the block is affected by *rocking & sliding*, if it comes from the motion of pure *rocking*.

From the discussion of the theory of the impact it appears evident that, independently of the contingent conditions of motion, the coefficient of restitution is able to give us information about the evolution of a motion that passes through the impact with the support.

Summarising and schematizing the different circumstances that may occur are:

$\boldsymbol{e=0}$	**THE BLOCK REST**
$\boldsymbol{e<0}$	**THE BLOCK BOUNCES OFF** (this possibility is not included in the impact theory)
$\boldsymbol{e=1}$	**THE BLOCK DOESN'T LOSE ENERGY DURING THE IMPACT**
$\boldsymbol{e>0}$	**THE BLOCK LOSES ENERGY DURING THE IMPACT**

4.5.9. Evolution between the various types of motion.

The different sequences of motion, which may affect the rigid block, are effectively summarized in Figure 4.15.

As can be observed, except for the connection to the *rest-sliding* and *rocking-sliding & rocking*, which are reversible, in any other case the return to the same type of motion can only occur through the impact. In other words, the speed change is continuous only when it has the transition from the *rest* to the *sliding* or from *rocking* to *rocking & sliding* and vice versa, instead takes in correspondence of a discontinuity of the velocity function, when it passes through the impact, admitting that occur energy losses.

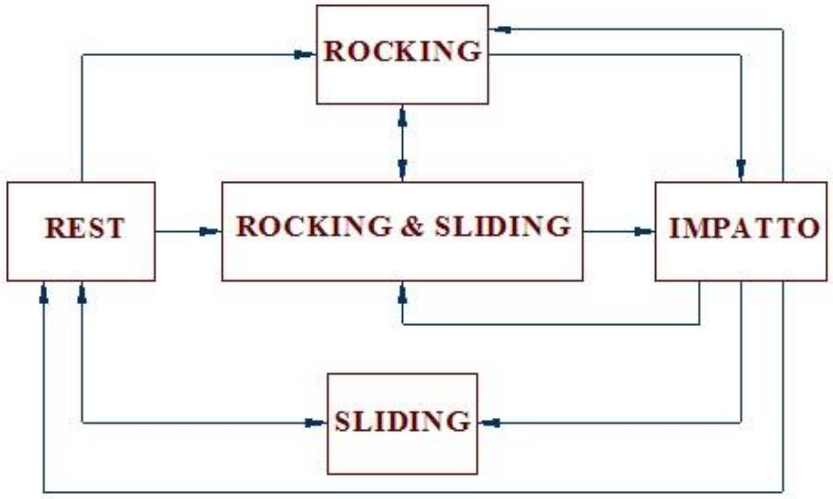


Figure 4.15

4.5.10. Rocking for systems to two blocks.

Consider the case of two overlapping blocks of Figure 4.17.

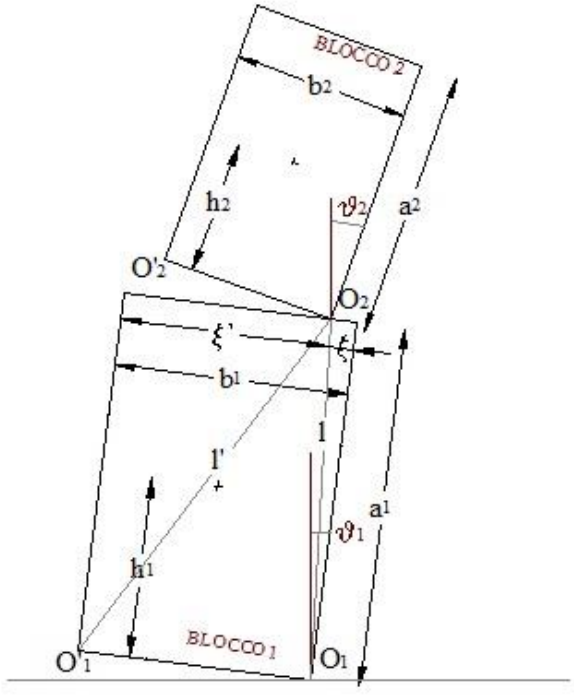


Figure 4.17

The upper block, indicated in Figure as a block 2, is superimposed symmetrically to the lower one, the block 1. It is assumed that the coefficient of friction at the base and at the

interface between the blocks is high, so as to exclude sliding both in absolute and relative terms.

The system has two degrees of freedom, denoted by ϑ_1 and ϑ_2, and is subjected to horizontal and a vertical component of excitation to the base, $\ddot{x}_g$ and $\ddot{y}_g$. There are different possibilities of vibration of the system: the blocks rotate in the same direction, in opposite directions, they behave as a single block, or block 1 remains stationary and the block 2 rotates. The different types of motion are shown in Figure 4.18.

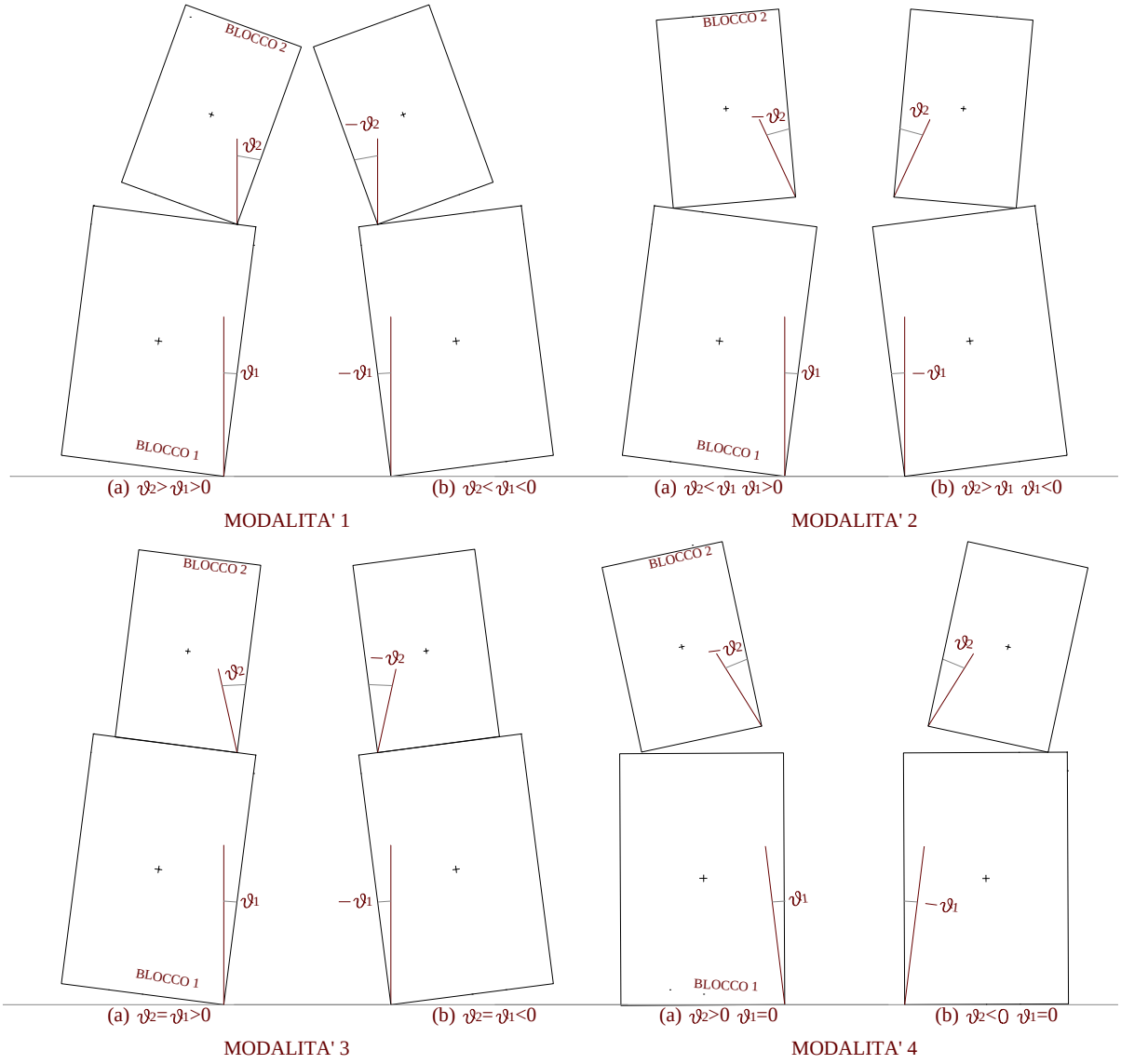


Figure 4.18

Depending on the sign of the rotations can be distinguished among the subcases (a) and (b), being able to write two different systems of equations.

To proceed with the linearization of the equations of motion, it can be assumed that the rotation angles are small enough to be considered valid positions $\sin\theta_i \cong \theta_i$and $\cos\theta_i \cong 1$ for *i=1,2*, and neglect second order terms, obtaining:

MODE 1

$$\begin{bmatrix} I_{O1}+m_2l^2 & m_2\left(a_1h_2+\frac{b_2}{2}\xi\right) \\ m_2\left(a_1h_2+\frac{b_2}{2}\xi\right) & I_{O2} \end{bmatrix}\begin{Bmatrix}\ddot{\theta}_1\\ \ddot{\theta}_2\end{Bmatrix}+ \begin{bmatrix}-(m_1h_1+m_2h_2)g & 0\\ 0 & -m_2h_2g\end{bmatrix}\begin{Bmatrix}\theta_1\\ \theta_2\end{Bmatrix}= \begin{Bmatrix} \mp\left(m_1\frac{b_1}{2}+m_2\xi\right)g \mp\left(m_1\frac{b_1}{2}+m_2\xi\right)\ddot{y}_g-(m_1h_1+m_2a_1)\ddot{x}_g \\ \mp m_2\frac{b_2}{2}g \mp m_2\frac{b_2}{2}\ddot{y}_g-m_2h_2\ddot{x}_g \end{Bmatrix} \quad (4.85)$$

MODE 2

$$\begin{bmatrix} I_{O1}+m_2l'^2 & m_2\left(a_1h_2+\frac{b_2}{2}\xi'\right) \\ m_2\left(a_1h_2+\frac{b_2}{2}\xi'\right) & I_{O2} \end{bmatrix}\begin{Bmatrix}\ddot{\theta}_1\\ \ddot{\theta}_2\end{Bmatrix}+ \begin{bmatrix}-(m_1h_1+m_2h_2)g & 0\\ 0 & -m_2h_2g\end{bmatrix}\begin{Bmatrix}\theta_1\\ \theta_2\end{Bmatrix}= \begin{Bmatrix} \mp\left(m_1\frac{b_1}{2}+m_2\xi'\right)g \mp\left(m_1\frac{b_1}{2}+m_2\xi'\right)\ddot{y}_g-(m_1h_1+m_2a_1)\ddot{x}_g \\ \mp m_2\frac{b_2}{2}g \mp m_2\frac{b_2}{2}\ddot{y}_g-m_2h_2\ddot{x}_g \end{Bmatrix} \quad (4.86)$$

MODE 3

$$\left.\begin{matrix} I_O\ddot{\theta}_1-mgh\theta_1=\mp m\frac{b_1}{2}g \mp m\frac{b_1}{2}\ddot{y}_g-mh\ddot{x}_g \\ \theta_2=\theta_1 \end{matrix}\right\} \quad (4.87)$$

MODE 4

$$\left.\begin{matrix} I_{O2}\ddot{\theta}_2-m_2gh_2\theta_2=\mp m_2\frac{b_2}{2}g \mp m_2\frac{b_2}{2}\ddot{y}_g-m_2h_2\ddot{x}_g \\ \theta_1=0 \end{matrix}\right\} \quad (4.88)$$

where:

- m_1 , m_2 respectively the masses of the blocks 1 and 2;
- I_{O1}, I_{O2} moments of inertia of the blocks with respect to the vertices of the base;
- $m=m_1+m_2$ total mass of the system;
- I_O moment of inertia of the system with respect to O_1;
- h height of the centre of mass of the system.

Each of the equations written is linear, but the conditions of the transition between rest and motion, or between different types of motion, can be represented by nonlinear equations, which are obtained by writing the equilibrium equations of forces, in a very similar way than the case of the single block. It is also necessary take into account the energy losses associated with the impact.

4.6.Requirements for the protection of artistic assets

Referring to the different categories of objects described in § 4.3 and the response characteristics of dynamic analysed in the previous paragraphs, was formulated a technical sheet [30], usable even by unskilled operators to select the protective measures to be taken in the set-up of a new museum or in the seismic adjustment of an existent museum.

In the schedule, shown in Table 4.8, are identified for different categories of objects and types of behaviour (R1, R2, R3, R4, R5, R6), which must be identified taking account of the characteristics of the action evaluated with reference to the site where lies the Museum and defined by the peak values of acceleration a_g and velocity v_g, obtained considering also the filtering effect of the building structure and eventually the showcases for the site where the museum is located.

The authors [30], for each category propose some measures to adopt (I1, I2, ..., I8) and the sequence in which they should be taken into consideration, from 1 to 5 depending on the case. Table 4.9 describes the types of intervention.

Table 4.8. Definition of intervention strategy based on the type of object and the conditions of the motion.

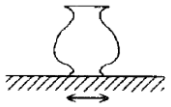
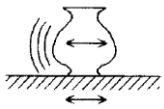
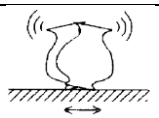
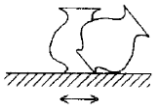
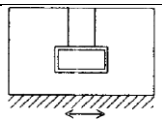
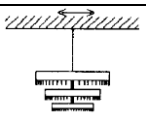
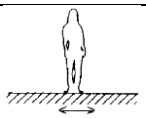
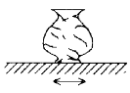
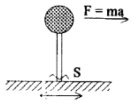
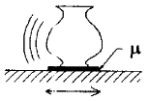
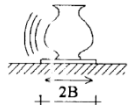
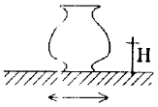
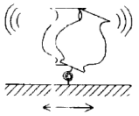
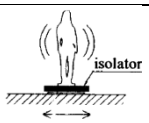
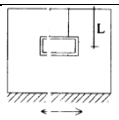
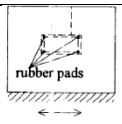
	POSSIBLE MOTIONS AND ASSOCIATED CONDITION			INTERVENTIONS (in sequence), AND DAMAGE/FAILURE MECHANISMS								
Type	$\frac{a}{g} > {}^{B}/_{H}$	$\frac{a}{g} > \mu$	$v < 10{}^{B}/_{H}$	I1	I2	I3	I4	I5	I6	I7	I8	
R1	NO	YES	-	1	2			3				
	Stick motion			Excessive stress								
R2	NO	YES	-	1	2			3				
	Sliding motion			Excessive displacement								
R3	YES	NO	NO	4	1	2	3	5				
	Oscillations			Repeated impacts								
R4	YES	NO	YES	4	1	2	3	5				
	Overturning			Overturning								
R5	-	YES	-							1	2	
	Sliding motion			Excessive displacements								
R6	-	-	-							1		
	Oscillations			Excessive displacements								
R3-R4	YES	-	-						1			
	Oscillations, overturning			Excessive stress, repeated impacts								
R3-R4	YES							1				
	Oscillations, overturning			Excessive stress, repeated impacts								

Table 4.9. Description of checks and interventions on the art objects

TYPE OF INTERVENTIONS	DESCRIPTION OF INTERVENTIONS	
I1	The resistance of the critical points (e.g. the section S, in figure) is checked	
I2	The friction between the base of the object and the supporting plane in reduced by interposing a special material like Teflon.	
I3	The base of the object is widened by means of a special device.	
I4	The centre of mass of the object is lowered (e.g. by filling a vase with sand)	
I5	A natural or synthetic rubber isolator is introduced.	
I6	A mechanical isolator is introduced.	
I7	The length of the hangers is chosen such to limit the inertia force in the object.	
I8	In addition to I7, rubber pads are interposed between the object and the wall.	

5. The standards for preservation and conservation

5.1. Introduction

The "*Guidelines for the evaluation and reduction of seismic risk of cultural heritage*" [26] have been drafted with the intent to specify a path of knowledge, assessment of the level of security against seismic actions and design of any interventions for the protected cultural heritage (DPCM 09/02/2011, 2011). The aim is to express a judgment on the safety and conservation and leading eventually to the seismic improvement interventions, as required by Article 29 of the Code of Cultural Heritage and Landscape [5]. However, the principles contained in them should be extended to other types of artefacts, such as archaeological and movable heritage, exposed and preserved in museums and diffused throughout the national territory.

The seismic evaluation of movable assets present in historic buildings, however, is more complex due to the different characteristics that such assets have. It is therefore necessary to resort to proper analysis of assets exposed in historic artefacts. The aim of this work is therefore to provide a survey register that is helpful to the phase of knowledge for the evaluation of the seismic vulnerability of the different types of movable heritage on territory, being this phase a basic precondition for a reliable seismic safety evaluation, and for the selection of appropriate interventions to be performed.

The path of knowledge developed in vulnerability sheet, cannot do without a thorough investigation of the building in which the object is contained, as the interaction between the two may affect the assessment of the safety level of the object. In the phase of knowledge should be collected all the information able to give back the history of the good that one wants to assess, starting with a survey of the factory, which is the study of the original features and changes that occurred over time due to various phenomena of damage, until to get to each object inside the artefact.

The survey path is divided into two distinct phases the first of which is directed to the building and the second to the individual object.

In the first analysis phase the sheet explores the following aspects of the building in which the object is located:

- construction identification;
- geometric consistence of the building in its current state;
- identification of the elements constituting the system resistant, meaning in material and construction sense.

The second analysis phase of the sheet focuses on the single object with the consequent study of the following aspects:

- identification of typological class of artistic assets, its location in relation to the construction, the author and the dating;
- identification of the elements constituting the artistic assets, meaning in material and construction sense;
- geometric and material survey of the object in its present state, with the description of any cracking and deformation phenomena.

Thanks to the data collected in the sheet, one can define a reliable mechanical model in order to make an accurate assessment of the seismic vulnerability of the artistic assets and to make decisions about future actions.

5.2. Fast survey of the cultural heritage in seismic areas

The sheet for the evaluation of the seismic vulnerability of the movable heritage is a tool for the systematic and reasoned collection of information on the typological characteristics and the damage of artistic assets exposed in a protected building. This allows for a fast survey of the protected heritage, and is a valuable aid in the process of knowledge of goods, as it provides a guided path in collecting information, by geometric survey to the state of preservation, which guide the risk assessment and evaluation of the interventions needed.

The operations of compiling can be done in two distinct phases, not necessarily consecutive: in fact some information may be derived from the consultation of the bibliography available, while other data have to be collected through specific investigations.

The data that must be collected and inserted are both qualitative and quantitative, and can be observed during the surveys and therefore refer only to what is visible, or come from the results of diagnostic analysis.

The sheet proposed, suitably completed, allows to reach a high level of knowledge of good and in particular allows, on the base of the data collected and recorded, a first quantification of the effects of a natural disaster on an artistic assets.

Given the simplicity and speed of information collection, the sheet can be used easily for any type of artistic assets.

The structure of the sheet to the movable heritage is such as to allow a progressive knowledge of the asset through a sequence of modules and sub-modules, which allow the collection of a set of information on the assets, by the location to the identification of the object, by execution technique to the material used, by the state of conservation to the type of interventions, up to the identification of a risk indicator with an prediction of interventions executables.

The different modules identify some macro groups of information concerning:

- *identification of the* building in which the asset is located, contains general information concerning the denomination of the building, its location in relation to the urban context as well as dimensional information and the period of construction and any restoration interventions;
- *identification of assets,* early stage in the path of knowledge for the seismic vulnerability assessment, classifying the assets within a defined category;
- *state of preservation gives*, an judgment on the state of maintenance and integrity of the asset, both from the maintenance point of view that of the previous damage;
- *monitoring,* definition of a maintenance program and accurate monitoring in order to follow the evolution of the degradation phenomena over time and thus ensure the preservation of assets over the years.

In the following paragraphs are a brief description of the information macro groups collected in the sheet and some illustrations of modules.

5.3. Identification of the construction

The first step of the knowledge consists in the correct identification of the structure and its location on the territory, in order to identify the sensitivity of the building in respect of seismic risk [26]. The first section of the sheet concerns the building in which the artistic assets are exposed. This section provides general information concerning in

detail the artefact itself by the author at the time of construction, by the executive technique to the state of preservation [35] [36].

In this phase all the information that is useful for a first and quick assessment of critical situations and seismic vulnerability will be acquired.

The subsections of this first phase concern:

- *identification of the building*, provides information regarding the territorial location of the building, the current destination of use and the owner of the asset;
- *dimensional data and age of construction / renovation,* collecting all the information starting from the metric survey of the building, in this context will be identified the time of construction and interventions that building has suffered in previous years;
- *the main structural material of the vertical structure,* identification of resistant structures, through the survey of materials, of degradation and instabilities, should be also taken into account the quality and state of conservations of materials and construction elements.

5.3.1. Identification of the building

The first step of the knowledge consists in the correct identification of the structure and its location on the territory, in order to identify the building sensitivity in respect of seismic risk. First of all, must be identified the individual structural aggregates, understood as a set of buildings (structural elements) not homogeneous, in contact or with a connection more or less effective, which may interact under a seismic action or dynamic in general. A structural aggregate can be constituted by a single building or multiple buildings merged with constructive characteristics generally different. Next, the relationship of the building with its surroundings must be analysed through the description the architectonic complex, isolated or not, and the characterization of the spatial and functional relationships between the building and any conterminous artefacts, in order to assume the hierarchy constructive and relationships between the building and the context. In particular, starting from the concept of architectural complex, formed by the aggregation of several buildings and spatially defined by the streets that surround it [37], can be traced the origin of building, identified through the analysis of visible fronts and the plano-altrimetic articulation.

Are then collected a series of information that allows to facilitate the identification of the building at territorial level and national level (Table 5.1), such as the set of ISTAT codes. The collection of this information is important for mapping more detailed of the data about the consequences of the earthquake, compared to the scale of the entire municipality [36].

Regarding *use* will indicate all types of use may be present in the building and the relative number of units, making sure to indicate the percentage of use of the building in terms of space and/or time.

Table 5.1. Sub-1: Identification of the building

Identification of the building					
State			Istat Code		
Province			Istat Code		
Town			Istat Code		
Suburb/Small town					
Name of street					
Number of street		Zip code			
Sheet n°		Date			
Building complex made up			buildings		
Identification code					
Cadastral date		Cadastral sheet		Cadastral attached	
Cadastral Unit					
Position of building	1 ○ Isolated	2 ○ Inside	3 ○ Extremity	4 ○ Corner	
National grid reference					
E					
N					

Current name of building
Owner
User

5.3.2. Dimensional data and age of construction / renovation

In the next step (Table 5.2) will collect information about the metric data, the age, indicating the period of construction and any restoration of the building and the type of intervention that was made [38].

In the metric data should be entered the total *number of plans* including those underground, the *number of underground levels*, the *average height of the plan* and the *average area of floor*.

In the column concerning the *age* must be ticked the section relating to period in which the building was built and possibly one in which it has suffered a significant *restructuring* by structural point of view. It will be useful also identify the type of intervention, distinct from the Code of Cultural Heritage [5] in *Seismic Adaptation, Seismic Improvement, Other* (interventions that have affected the structural parts of the building but are not classifiable as seismic adaptation or seismic improvement).

After a preliminary investigation, the most important aspects should be investigated through an appropriate historical survey, which will be targeted to the identification of the different phases of construction. These research materials will allow to investigate the functional evolution of the building in order to understand the reasons for the structural and geometric changes that occurred over time, to motivate any signs or news of instabilities, and eventually to design possible future uses compatible with the characteristics of the building and with the objective of reducing seismic risk.

Table 5.2. Sub-2: Dimensional data

Dimensional data and age of construction/renovation									
No. of floors undergro und		Average height of plane [m]		Average area of floor [m^2]		Volume subject to verification [m^3]		D	Year of designing	
A		B		C		H		E	Year of completion of construction	
F	○ No intervention performed on the structure after construction									
G	Year of designing last intervention		G1	Adaptation	G2	Improvement		G3	Other	

5.3.3. The main structural material of the vertical structure

In this sub-module is identified the main structural scheme and it is aimed at the knowledge of building elements with particular attention to detail and the connections between the different elements [39] [40]. For each artefact must be measured the geometries of all the elements in masonry, vaults (thickness and profile), floors and roof (type and warping), stairs (structural typology), any possible niches, cavities, openings closed, included extraneous elements and the foundations' typologies, in order to identify the structural scheme. In particular, they must be collected information relating both possible cracks and any deformation, to allow the identification of the causes and possible evolution of the structural problems.

Particular attention should be given to the identification of areas of possible discontinuities and material inhomogeneities (added bodies, elevations, replacement of horizontal structures, etc.), and consolidation interventions made in the past as a result of natural events (localization and structural elements involved, the period of realization).

Taking into account the material used and its texture in the walls, the quality of the mortar and construction methods, the masonry structures [39] can be divided into two classes:

- *Masonry type I:* irregular texture and bad masonry quality;
- *Masonry type II:* regular texture and good masonry quality.

The horizontal structures are divided two main classes: flat and vaulted, and within each of these main classes there's a further distinction in relation to the characteristics [36].

As regards the horizontal elements vaulted, the basic distinction is between:

- *vault without tie rods*;
- *vault with tie rods*.

As for the flat structures (floors), the sheet distinguishes three types, according to their deformability in the plane:

- *Beams with deformable slab*;
- *Beams with semi-rigid slab*;
- *Beams with rigid slab*.

Additional information concerning:

- *Presence of isolate columns*;
- *Presence of a mixed structure type*;
- *Presence of reinforced masonry*.

A global assessment on the *regularity* or irregularity of the building both in plants and elevation must be expressed.

Finally it identifies the type of *roof*, using as basic parameters weight and the type of roof [36]:

- *pushing heavy*;
- *not pushing heavy*;
- *pushing light*;
- *Not pushing light*.

According to the information collected in this sub-module will be possible understand the behaviour of the building and identify any seismic improvement interventions.

Table 5.3. Sub 3: Main structural material of the building

Main structural material of the vertical structure								
Vertical Structures / Horizontal Structures	**Not identified**	**Masonry structures**				**Isolated columns**	**Mixed**	**Reinforced**
		Irregular texture and bad quality		**Regular and good quality**				
		Without tie rods	With tie rods	Without tie rods	With tie rods			
	A	B	C	D	E	F	G	H
Not identified	○	□	□	□	□	YES	□	□
Vault without tie rods	□	□	□	□	□	○	G1	H1
Vault with tie rods	□	□	□	□	□		□	□
Beams with deformable slab	□	□	□	□	□	NO	G2	H2
Beams with semi-rigid slab	□	□	□	□	□	○	□	□
Beams with rigid slab	□	□	□	□	□		G3	H3

Regularity	**Irregular**	**Regular**	**Roof**		
	A	B			
Plan and ground elevation	○	○	1	○	Pushing heavy
			2	○	Not pushing heavy
Presence of non-structural elements	○	○	3	○	Pushing light
			4	○	Not pushing light

Constitutive elements								
Material	Sandstone	□	Limestone	□	Tuff	□	Calcarenite	□
	Baked bricks	□	Mud brick	□	Reused material	□	Other	□
Manufacturing	Absent (pebbles)	□	Minimally processed blocks	□	Sharp-ended	□	Square blocks	□
Size (diagonal element)	Small (< 15 cm)	□	Medium (15 - 25 cm)		□		Large (> 25 cm)	□
State of conservation and quality	Very bad	□	Discreet		□		Good	□
Mortar								

Type	Air lime	□	Hydraulic lime	□	Cement	□	Other	□
State of conservation and consistency	Incoherent	□	Friable		□		Adhesive	□
Role	Mortar base	□	Filling		□		Stilatura	□
Laying of the elements								
Texture of masonry facings								
Equipment	Disorderly	□	Irregular		□		Horizontal	□
Laying of element	Disorderly	□	Herringbone	□	Horizontal/vertical	□	Horizontal	□
Borders	Absent	□	Brick		□		Other	□
Wedges or flakes	Absent	□	Stone		□		Brick	□
Transversal section								
Type	Single facing	□	Two facings combined		□		Two facings connected	□
	A sacco (inconsistent)	□	A sacco (consistent)		□		Facing added	□
Thicknesses	Total	□	Outside facings		□		Facing internal	□
Presence of voids		□	**Presence of "diatoni"**					□
Plaster								
Current state	Exposed masonry	□	Absent	□	Partially absent	□	Present	□
State of conservation and consistency	Deteriorated	□	Cracked		□		Good	□
Connections between the masonry walls								
Angolate								
Type	Poor connections	□	Irregular connections		□		Regular alternation	□
Constitutive elements	Similar to the masonry	□	Of the greater size		□		Square blocks	□
Martelli								
Type	Connections absent	□	Poor connections		□		Efficient connections	□
Different types of connecting walls		□	**Presence of tie rods**					□
Interventions of consolidation								
To the masonry	None	□	Indenting in brick		□		Indenting in stone	□
	Stilatura	□	Mortar injections		□		Armed plaster	□
To the connection elements	None	□	Closure of openings	□	Connecting beams	□	Tie rods	□
	Seams armed	□	Masonry curb	□	Reinforced concrete curb	□	Rigid horizontal structures	□

5.4.Identification of the artistic assets

The second section of the concerns in particular the artistic assets. This section provides general information concerning in detail the artistic assets itself by the author to the time of creation, by the executive technique to the state of preservation.

In this phase all the information that is useful for a first and quick assessment of the seismic vulnerability and of critical situations will be acquired, including the movable heritage in suitable classes identified on the basis of their seismic response.

The subsection of this second phase, therefore, concern:

- *identification of the artistic assets,* includes information relating to the movable heritage itself, indicating the author of the cultural context in which it was made, therefore, proper dating, and its location within the artefact;
- *typological and dimensional data,* identification of the type and construction technique accompanied by a first survey of movable heritage and its supports in its present state, in this context will be identified also previous intervention that the movable heritage has suffered;
- *classification of the artistic assets,* identification of a class of the movable heritage, for the seismic protection, based on the mechanical behaviour.

5.4.1. Identification of the artistic assets

An essential phase in the path of knowledge of the artistic assets is the collection of all the information about the movable heritage itself and the author who created it. In this phase of analysis will identify not only the general characteristics of the work but also information regarding the subject represented [41]. The critical analysis of the movable heritage will be accompanied by a historical analysis, which allows to collect information and details, such as drawings or photographic documentation, making it possible to fully reconstruct the history of the property (Table 5.4). On the base of the data collected will be possible to understand the aspects that contributed to the formation of degradation and instabilities. The *Object, Subject, Author*, and *Cultural Level* must be filled reporting the date of the movable heritage in the field of *History/Dating*.

In this phase should also be collected data on the location of the artistic assets respect to the building, *Location* and *Specific Location*, so as to identify the movable heritage

inside the building analysed in the first section of the sheet. This aspect aims to underline the possible interaction between the "container" and the "content" in the case of seismic event, as the vulnerability assessment of artistic heritage cannot be separated from the study of the seismic response of the building itself.

Table 5.4. Sub 1: Identification of artistic assets

Identification of the artwork						
Object						
Subject						
Author						
Cultural Context						
Chronology	year		century	era		
Position	Church	□	Museum room	□	Palace	□
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	□	Wall sx	□	Lunette dx	√
	Lunette sx	√	Vault	□	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	□

5.4.2. Dimensional and typological data

To understand the relationship between the artistic assets and the surrounding environment and define mechanical models used for the seismic vulnerability assessment, the dimensional and typological characteristics submodule must be filled [41]. The information provided may achieve different levels of detail, from approximate and faster measurements to application of innovative and accurate techniques.

The term *Measures* (in cm) relates the data related to: *height, depth, width and diameter*. In the field *Type* the movable heritage is classified according to its specific characteristics. In the field *Previous restorations* is necessary to indicate the year of the last interventions made, reporting *interventions documented or not*, the *presence of renovations and/or additions*, the presence of *holes, nails, brackets, clamps, sketches, electric cables*, having care to take note, where possible, the year of implementation (Table 5.5).

Table 5.5. Sub 2: Dimensional e typological data

Dimensional and typological data

Measures [cm]	Height [H]		Depth [P]		Length [L]		Diameter [D]	
Typology	Movable	□			Immovable		□	
	Isolated artwork	□			Series		□	
	Fragments	□			Other		□	
	Note							
Previous restorations	Interventions documented	□			Interventions not documented		□	
	Note							
	Renovations/addition							
	Holes	□	Nails	□	Screws	□	Clamps	□
	Brackets	□	Plastering	□	Stucco	□	Electric cable	□
	Note							

5.4.3. Classification of the artistic assets

To formulate appropriate criteria and measures for the protection of artistic assets, it is necessary to understand their behaviour in case of earthquake. However, given the variety of types of movable heritage is necessary first of all a *classification* from the point of view of their mechanical behaviour (Table 5.6).

Before proceeding to the classification of the work on the basis of their seismic behaviour, the sheet includes a section dedicated to different types of works located in a protected building. The field *Materials* gives the information about the materials used in the construction of the movable heritage, with reference to the individual elements that characterize the object itself. A further classification is performed in the field *Classification of artistic assets*, which allows to identify some macro-categories of objects to which correspond simplified models both of the dynamic response and damage mechanisms more likely. This classification must respect some conditions, or:

- be characterized by very large classes, both for simplicity and because it is quite common that objects of form and different nature have behaviour attributable to a single model under the action of seismic ;
- also consider the type of support, that is the element on which the object is located

or that constrains it, and that influences the dynamic response of the object, often significantly. To the model of the object or system "*object* + *support*" is then associated with the type of prevailing behaviour, so that to it is possible to match a specific damage mechanism.

It becomes possible to impose appropriate conditions on the seismic response for each category, and devise ways to ensure compliance with these conditions.

Table 5.6. Sub 3: Typological classification of artistic assets

Typological classification of artistic assets								
Typology	Type		No.	Area	Type		No.	Area
	Frescoes	□			Altars/statues	□		
	Mosaics	□			Books/graphics print	□		
	Stucco	□			Movable painting	□		
	Tapestry	□			Furnishings	□		
	Plastic decoration	□			Paper manufactures	□		
	Archaeological evidences	□			Other	□		

Materials								
Support structures	Fixed	□	Movable	□	Suspended	□		
	Cabinet	□	Easel	□	Shelf	□		
	Showcase	□	Pedestal	□	Roof	□		
	Wall	□	Floor	□	Panel	□		
	Shelves	□	Rack	□	Other	□		
	Note							
Auxiliary support structures	Bracket	□	Frame	□	Nails	□		
	Cable or wire	□	Masonry base	□	Parchettature	□		
	Other					□		
Support	Canvas	□	Wood	□	Metal	□		
	Glass	□	Paper	□	Stone	□		
	Lather	□	Vellum paper	□	Plaster /masonry	□		
Auxiliary support structures	Frame	Integral to the support or part of it			□	Yes □	No □	
		Rigidly constrained			□	Yes □	No □	
		Wooden	□	Metal	□			
		Plaster	□	Fillet	□			
		Moulding	□	Golden	□			
		Paint	□	Notched	□			
		Inlaid	□	Other	□			
	Framework	Wooden	□	Rigid	□			
		Metal	□	Decomposable	□			
		Movable	□	Other	□			
Preparatory layers	Stucco	□	Plaster	□	Glue	□		
Paint film	Oil paintings	□	Tempera paintings	□	Watercolours	□		

Classification of artwork

Art object typological categories		
T1	□	Small, flat-bottomed objects
T2	□	Small, not flat-bottomed objects
T3	□	Statues, sculptures and large vases
T4	□	Paintings and panels
T5	□	Chandeliers
T6	□	Others

Support/restraint in relation to categories								
	A				B	C		D
	Object supported on a flat plane				Objects fixed on a flat plane	Suspended/hanging objects		Other
	A1	A2	A3	A4		C2	C2	
	On the floor	On a pedestal	In display cases	On cantilever or in wall cases		Suspended on a wall	Hanging from the ceiling	
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	-	*	-	-	-
T4	-	-	-	-	-	*	-	*
T5	-	-	-	-	-	-	*	-
T6	*	*	*	*	*	*	*	*

Dynamic and damages response mode for different types of artistic assets					
Class	*Dynamic mode*		*Damage mode*		*Abbreviation*
A	Stick motion	□	Excessive stress	□	R1
	Sliding motion	□	Excessive displacement	□	R2
	Oscillations	□	Repeated impacts	□	R3
	Oscillations	□	Overturning	□	R4
B	Stick motion	□	Excessive stress	□	R1
C	Oscillations	□	Excessive displacement	□	R5 R6
D	Stick motion	□	Excessive stress	□	R1
	Stick motion	□	Excessive displacement	□	R2
	Stick motion	□	Sliding	□	R7

In the field of *Classification according to the type* is identified the class of the movable heritage based on its typology. In the field of *Classification based on the type of support* the movable heritage is identified in a subclass that is defined by the support of the objects, on the base of the first class identified. Each type of movable heritage is then associated with a category that identifies the possible *Dynamic response mechanisms*, *Damage mechanisms* and the *Prevailing mode of response* [30] [31] [42] [43].

5.4.4. State of preservation of movable heritage

Although the protection of cultural heritage is now a common prerogative, many movable heritages suffer a slow deterioration that compromises the integrity of the objects also from a cultural point of view. The survey on the materials will lead to a complete characterization of the artistic assets, but that will linger mainly on the quality and on state of preservation of the material [44] [45] [46]. The alteration and degradation phenomena affecting the object and all the elements that characterize it must be discovered identifying their origin (Table 5.7). In order to properly define the state of alteration is appropriate to identify the location and intensity of the damage, adopting different levels of investigation: from simple visual examination to non-destructive analysis [47].

During this analysis phase will acquire the information that is useful to the identification of direct and indirect damage present on the movable heritage.

The possible direct and indirect damage caused by the earthquake are therefore:

- *cracks:* survey of deep or superficial cracks;
- *deformation:* these damages are usually produced from humidity or mechanical stress;
- *fragmentation:* presence of detached or fragmented parts.

According to the data collected and the level of damage, and on the basis of the class of the movable heritage, will be identified the most appropriate interventions to be implemented for the preservation and protection, including the development of an adequate monitoring program.

Table 5.7. Sub 4: State of preservation of movable heritage

General state of preservation artwork							
Good	□	Not bad	□	Poor quality	□	Very bad	□

State of preservation of artwork						
Frescoes						
Plaster	Detachment	□	Swelling	□	Crumbling	□
	Surface deposit	□	Loss	□	Cracks	□
	Damages	□	Gap	□	Moisture stains	□
	Lack	□	Salt efflorescence	□	Other	□
Paint film	Decohesion	□	Moisture stains	□	Detachment in dust	□
	Colour loss	□	Biological patina	□	Slivers detachment	□
	Other					□
Stucco						
Support	Biological patina	□	Detachment	□	Cracks	□
	Stains	□	Gap	□	Lack	□
	Other					□
Metal support	Lack of support	□	Oxidation	□	Corrosion	□
	Deformation	□	Pitting	□	Other	□

Paintings on plaster						
Plaster	Detachment	□	Swelling	□	Detachment in dust	□
	Lack	□	Cracks/damages	□	Crumbling	□
Paint film	Salt efflorescence	□	Surface deposits	□	Gap	□
	Damages	□	Cracks	□	Lack	□
	Other					□
Paintings on canvas						
Wooden frame	Aggression by insects	□	Copper salts	□	Chromatic changes	□
	Marcescence	□	Rust stains	□	Dry rot	□
	Other					□
Metal frame	Deformation	□	Oxidation	□	Corrosion	□
	Pitting	□	Other			□
Support	Laceration	□	Split	□	Slackening	□
	Aggression by insects	□	Burn	□	Moisture stains	□
Paint film	Detachment	□	Decohesion	□	Biological patina	□
	Detachment in dust	□	Moisture stains	□	Traces of burn	□
	colour loss	□	Salt efflorescence	□	Gap	□
	Other					□
Paintings on wood						
Support	Aggression by insects	□	Deformation	□	Marcescence	□
	Chromatic changes	□	Damages	□	Stains	□
	Other					□
Paint film	Colour loss	□	Detachment	□	Decohesion	□
	Detachment in dust	□	Moisture stains	□	Traces of burn	□
	Patina	□	Efflorescence	□	Gap	□
	Other					□
Sculptures, high reliefs, bas-reliefs in wood						
Support	Aggression by insects	□	Deformation	□	Lack (mutilations)	□

	Burn	□	Marcescence	□	Moisture stains	□
	Other					□
Paint film	Colour loss	□	Detachment	□	Decohesion	□
	Detachment in dust	□	Surface deposits	□	Traces of burn	□
	Gap	□	Efflorescence	□	Integration	□
	Other					□
Sculptures, high reliefs, bas-reliefs in stone						
Support	Cracks	□	Surface deposits	□	Crust	□
	Detachment	□	Chromatic changes	□	Differential degradation	□
	Crumbling	□	Erosion	□	exfoliation	□
	Scaling	□	Stains	□	Lack	□
	Patina	□	Film	□	Pitting	□
	Detachment in dust	□	Other			□
Sculptures, high reliefs, bas-reliefs in metal						
Support	Oxidation	□	Corrosion	□	Patina	□
	Pitting	□	Lack	□	Deformation	□
	Stains	□	Other			□
Ceramic products						
Support	Damages	□	Lack	□	Detachment	□
	Detachment in dust	□	Surface deposits	□	Patina	□
	Exfoliation	□	Salt efflorescence	□	Crus	□
	Stains	□	Other			□
Finishing	Exfoliation	□	Detachment in dust	□	Lack	□
	Moisture stains	□	Surface deposits	□	Gap	□
	Decohesion	□	Colour loss	□	Detachment	□
	Biological patina	□	Other			□

5.5.Case study: the museum complex of Santa Chiara in Naples

5.5.1. Introduction

The citadel of St. Chiara with its Basilica and the Monastery was among the first monasteries to be built in the historic centre of Naples. It was founded in 1310 by order of Robert of Anjou, King of Naples, and his second wife Sancia of Majorca.

The Basilica with its imposing size was realized in the forms of Provençal Gothic, a style that gives it the appearance of an impenetrable fortress. Between 1328 and 1333 was in Naples Giotto, who adorned the Franciscan Basilica with scenes of the Apocalypse and stories from the Old and New Testaments. Of this cycle, unfortunately, only fragments remain in the Choir, due to the bombing that the complex has suffered during the Second World War.

The phase of realization of the monastery lasted until 1340, when the basilica was consecrated. In 1343 the Tuscans Pacio and Giovanni Bertini realized one of the masterpieces of the fourteenth-century Italian sculpture: the funeral monument of Robert of Anjou, which, although incomplete still dominates in the background of the Basilica.

The monastery until the eighteenth century retains its Gothic appearance. In the years 1740-69 there was a radical change of the monastery and the Basilica. The church, in fact, covered with stucco and marble, was transformed into a sumptuous Baroque building. The Vaccaro, one of the architects of the Neapolitan Baroque, multifaceted, as capable of ranging between painting, sculpture and architecture, using the work of the Neapolitans Donato and Giuseppe Massa gave rise to the transformation of the cloister of the Clarisse, which acquired its present appearance, characterized by walkways with octagonal pillars and seats majolica. The *riggiole*, using the typical colours of the Neapolitan tradition, blue, yellow and green, giving rise to a *unicum*, baroque artifice that communicates with the surrounding colours and that made the cloister famous worldwide. In 1924 the number of the Clarisse became small, as a result of this, the Friars moved to the convent of the Clarisse and these last in the convent of Minors; this change has made possible the use of the cloister.

Another important phase in the history of the Franciscan citadel is constituted by the Second World War; during the allied bombing, which hit Naples on August 4 1943,

some fire bombs fell down on the church of St. Chiara. The result was a fire that destroyed the baroque setups that adorned the Basilica. The reconstruction, which lasted ten years, gave back the church in its original Gothic style, not without some controversy.

Between 1986 and 2001 were started and completed the restoration of the Majolica Cloister; in this period take place two important moments for the museum fruition of St. Chiara: May 27, 1995 and December 18, 1998. The first date is related to the opening of the *Museo dell'Opera di Santa Chiara*, which has four exhibition rooms, in which are collected Roman remains, are narrated the histories of the Franciscan citadel and are exposed marble and reliquaries that synthesize the artistic events in Naples from the Middle Ages to the nineteenth century. The museum contains works of great artistic value, such as the fourteenth-century **Fregio of St. Catherine**, by brothers Bertini, and the **Ecce Homo** by Giovanni da Nola, the most important Neapolitan sculptor sixteenth century. The second date, however, is related to stipulation of the convention with the *Fund for Religious Buildings* of the Ministry of Interior, which provides the management of a single monumental area called the *Museum Complex of St. Chiara*. This convention has allowed to extend the exhibition itinerary, to the *Museo dell'Opera* and to Archaeological Area with its Roman thermal building, have been added the famous Majolica Cloister and the hall of the eighteenth century Neapolitan nativity scene.

5.5.2. The restoration of the walkways and loggia, January 2013

In the context of the PhD in Company was possible to follow the restoration work that Brigante Engineering srl has conducted on the Museum Complex of St. Chiara, under the Financing Interministerial Decree of 01/12/2009. It was therefore possible to apply a first draft of the protocol previously described to the artistic heritage present inside that complex, starting by the frescoes in the cloister to the movable heritage exposed in the Museo dell'Opera.

The walls of the four wings of the great cloister are completely covered by a cycle of frescoes realized in the first half of the seventeenth century by an unknown artist influenced by the manner of Bellisario Corenzio, an artist of Greek origin who had a very strong influence in the Neapolitan art scene. The decoration running along the walls is divided into three distinct areas. Only in the south wing, due to the presence of large single lancet windows Gothic, the frescoes are further divided into two

sequences, and to the frames of the lower part overlap at the top a series of lunettes. This wing is separated from the others for the iconography: the saints in the series down, allegories and virtues in the top one. On the other three walls, however, the scenes depicting episodes from the Old Testament, with the exception of the frame on the north side with the "Death of a nun" realized in correspondence with the ancient cemetery of the Clarisse.

The Museo dell'Opera allows, however, to retrace the history of the city of Naples from the Greco-Roman period to the twentieth century. The exhibition rooms have been set up in the west wing of the Majolica Cloister, in rooms built on pre-existence Roman age. These structures, related to thermal environments, were rediscovered after the war during the restoration of the Church and Convent.

The rooms also expose the materials survived the fire of 1943 that damaged considerably the Church, destroying the baroque structures that once covered. The museum is divided into four rooms and allows access to the external Archaeological Area that fits in the museum.

5.5.3. Application of the survey protocol

According to the information collected and the analyses carried out, and with reference to the museum classification identified in §1.5, the Museum Complex of St. Chiara (Figure 5.1) belongs to the *great museums of art and archaeology housed in spaces originally built for other destinations, with low rate of computerization and with spaces to the custody of the historical evidence of the city of Naples and the ancient monastic citadel*.

Figure 5.1. The museum complex of Santa Chiara in Naples

The Appendix A reports the synthesis reports of the significant results obtained by the application of the survey protocol pertinent to different types of artistic assets exposed inside the museum complex.

5.5.4. Some considerations

The application of the survey sheets on artistic assets present in the complex it was possible to make some observations on the state of preservation of the artworks previously analysed.

In particular, it was found that the east walkway of the Cloister, is the one that presents more water damages coming from the upper loggia, which caused extensive *detachments of intonachino*. Some areas were full of water and in two points the humidity is so constant as to have caused the formation of a *patina* of autotrophic organisms (Figure 5.2).

Figure 5.2. East walkway: presence of autotrophic organisms in the vault (photos October 11, 2013)

In this walkway are also present pouring water which produced a slight fading on the paintings. In other places, the seat backrest of piperno (the fresco itself) presents abrasions due to the use of the seats. Lastly some lacunas are treated with neutral, always in the area of backrests.

The second walkway most affected by the same kind of damage is the south. Some areas were full of water, with the formation of a *patina* of autotrophic organisms, and *detachments of intonachino* (Figure 5.3).

Figure 5.3. South walkway: presence of autotrophic organisms and detachments of intonachino in vault (photo February 1, 2013)

The walkway north has not been much damaged by seepage, despite being present extended *intonachino detachments*.

Extended efflorescence are present, although in correspondence with stucco belonging to previous restoration and areas that have undergone humidity infiltrations. In other points, the seat backrest of piperno, also in this case the fresco itself, presents abrasion due to the use of the seats.

Similarly to the north walkway, the west walkway was not very damaged by infiltrations, despite the presence of some detachments of intonachino.

With regard the seats majolica, despite the last intervention dates back to 2001, are common the salt efflorescence caused by water infiltration and humidity and detachment of stucco designed during the last restoration to provide an even surface.
Different is the case of the movable heritage exposed in the Museo dell'Opera di Santa Chiara. As already highlighted above, the artworks in the museum have undergone a restoration during the new organization of the exhibition rooms (1999/2000), despite the passage of several years the state of preservation of most artworks is resulted decent. During the survey has been found, in correspondence of a wooden statue exposed on the upper floor of the museum, the presence of dust that have made think that the statue had been attacked by xylophage insects. A closer examination has revealed that these dust came from the wooden elements of the horizontal structures. It is clear, therefore, that the artworks are subject to a condition monitoring of temperature and humidity that has made sure that the artworks were preserved in time.

5.6. Case study: the Carthusian monastery of Trisulti in Collepardo

The Carthusian monastery of Trisulti (Figure 5.4) lies in the Apennines of Latium, in that part said of the Ernici. The foundation of the primitive monastery is attributed to St. Dominic by Sora, however of the ancient complex there are only ruined stone structures, including those of the church and the chapter house. In 1204 Innocent III entrusts to the monks of the Carthusian order what remains of the Benedictine monastery of St. Bartholomew. The danger of landslides and the difficulties linked to a different monastic organization, not satisfied by the existing structure, led to the creation of a new Carthusian monastery in a more suitable place. The work is completed in 1211 and the monumental complex was expanded and altered in the Baroque period and in the eighteenth century, until in 1947 the monks of Casamari, replace the Carthusians.

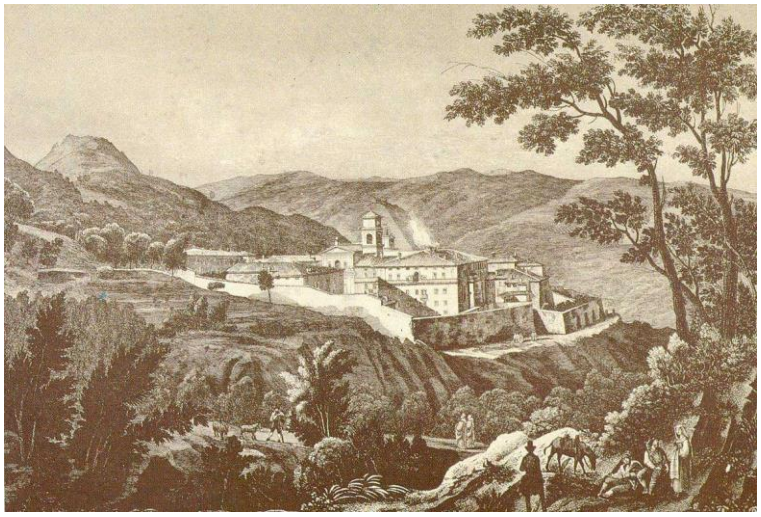


Figure 5.4. The Carthusian monastery of Trisulti, printing of 1700

The view of the Carthusians monastery offers a set of impressive buildings, in line with the tradition Carthusian and its functional and constructive requirements.

In fact, the main nucleus of Carthusian monasteries is characterized by the Cloister and the Church, around this are developed a number of secondary buildings, joined together by roads open or covered walkways and adorned by many gardens, fountains and works of Christian art.

The Carthusian monastery of Trisulti, presents the appearance more of a village that of a monastery (Figure 5.5). It is distinguished by a central nucleus, where there are the cloister, the Church with its outbuildings, the Refectory with the kitchen and the cellar, the apartment of the Prior, the Library and Archives. There are also secondary buildings: the Pharmacy, the Guest house, the laundry and the concierge building.

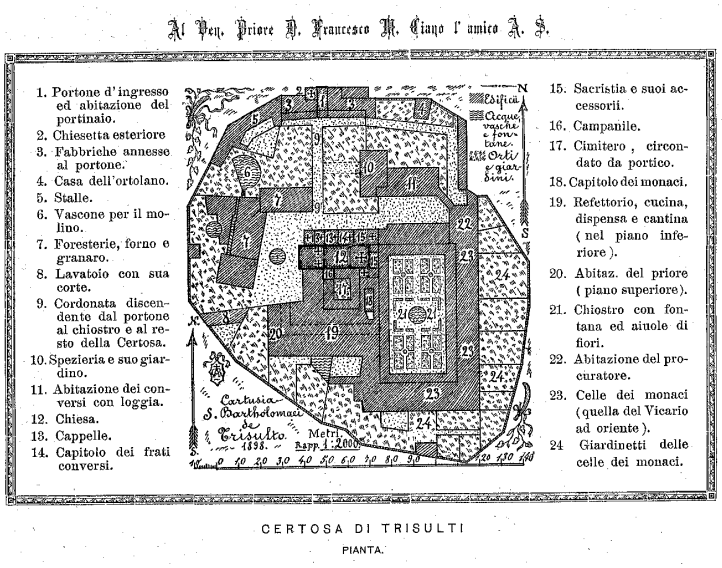


Figure 5.5. Plant of the Carthusian monastery of Saint Bartholomew Trisulti, 1898

The great Carthusian Monastery gate opens onto a large internal ramp that runs parallel between the high walls of the structure, opens on pharmacy, to get to the Palace of Innocent III, restored in 1958 with the portico on the ground floor and the library. The heart of the Carthusian monastery of Trisulti is the church of San Bartolomeo, which began in the early thirteenth century redesigned first with a Baroque face and then with façade with two orders in 1768. The interior is characterized by a single nave, covered by a barrel vault ogive. Two Carthusians choirs of 1600 anticipate the splendour of the main altar, a real cascade of marbles of 1774.

A covered passage leads to the cloister of the small cemetery of the monks, on which opens on the Chapter House and stands the majestic eighteenth century bell tower. A walkway leads to the rectangular large cloister, surrounded by a porch, from which you can access the eighteenth century refectory and the homes of *frates*, true treasure of the monastery.

5.6.1. Current state: critical issues

During the analysis carried out on the museum complex of the Carthusian monastery of Trisulti, the phase of structural knowledge revealed some critical issues for the conservation of the different Structural System that constitute the majestic museum complex (Figure 5.6), were, in fact, found different forms of alteration and damage.

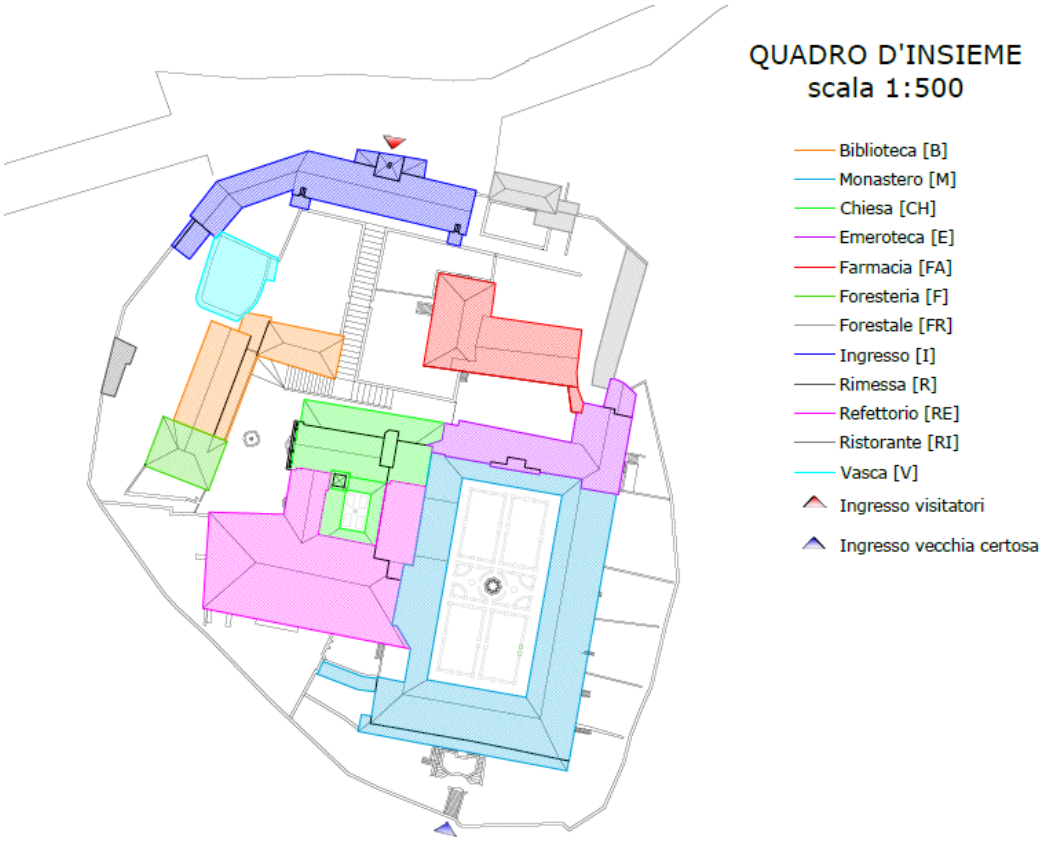


Figure 5.6. Overview of the museum complex of the Carthusian monastery of Trisulti (March 2014 survey)

Firstly was detected a deficiency of maintenance of roofs and bad regimentation of rainwater which caused infiltrations inside the attics with consequent degradation of the roof beams and the floors below. This phenomenon is particularly visible in the Refectory, Monastery and newspapers archive. The same phenomenon has caused the collapse or damage to the wooden false ceilings. Representative is the alarming rise of the beams deflection in the false ceiling of the room Balbi in ancient Pharmacy and the collapse of the wooden false ceilings in the Refectory locations placed above the location dedicated to the permanent exhibition of the Nativity Scene. A large proportion of the barrel vault, placed to cover the Church, has been affected by water damage by the roof that may damage significantly the frescoes inside.

In the second place were detected widespread phenomena of humidity in all buildings, but the most worrying situations were found inside the *Liquorificio* of Pharmacy and inside the Monastery. The phenomenon has caused the detachment of the surfaces

plastered and frescoed, the formation of biological patina, presence of efflorescence, the slight fading of the surfaces.

In the third place, there was a widespread crack pattern in the Monastery, in particular within the cells that overlook on the south-east, which makes part of the building sensitive with respect to local collapse mechanisms.

5.6.2. Diagnostic surveys functional to the validation of the survey of materials and construction techniques

In the path of knowledge, according to the Guidelines of MIBAC, the phases of survey of material and mechanical characterization of materials are aimed at defining the level of knowledge necessary for carrying out seismic vulnerability assessments. These activities need to be addressed, as done for the complex, following a thorough Historical Critique analysis which limits the need to conduct extensive investigations campaigns and allows to reach, through the execution only of non-destructive testing or weakly destructive, to an adequate knowledge of the structural behaviour and to a judgment on the quality of the materials and their degradation.

In order to achieve a comprehensive knowledge of the structure examined, it was necessary to lead a thorough investigation phase. The tests were aimed at the validation of the information derived from the historical and visual analysis of the complex. In addition, tests have validated the information obtained from various literature sources related materials and building techniques typical of the area.

The investigations were mainly non-destructive. The non-destructive techniques (ND) are commonly used to locate the hidden features of the masonry, the presence of voids, internal defects, the characteristics of the wall section and the degree of connection of the walls.

5.6.3. Thermographic Tests

The thermographic survey provides an important support to the path of structural knowledge of qualitative and semi-quantitative nature when supported by other ND tests, to complete the geometric survey and to find the relationship between the geometry and materials on the basis of historical evolution [5].

The thermography requires the use of the thermo camera an instrument that allows to detect the temperature distribution on the objects surface. It returns a thermal image in

colour scales associating differences in tones at intervals of temperatures of the order of the fraction of a degree centigrade. This is possible using the correlation between the intensity of the infrared rays, that a body emits, and its temperature. The infrared radiation is located between the portion of the electromagnetic spectrum of the visible and microwave.

The thermographic analysis performed were mostly passive, or exploiting the thermal cycles of natural sunlight and cooling.

An infrared thermos camera type FLIR E60bx was used for the relief structures. the camera has the following technical specifications: *IR resolution - 320x240 pixels; Spectral range 7.5-13 mM; FOV - 25 °×19 °; Spatial resolution - 1.36 mrad; Thermal sensitivity <0.045 ° C; Frame rate 60 Hz; Manual focusing; Focal Plane Array (FPA) - Uncooled microbolometer.*

During the survey activities conducted on the walls of the portico, have been found openings that probably during the interventions of 1958 have been closed to give the building again its original configuration (Figure 5.7).

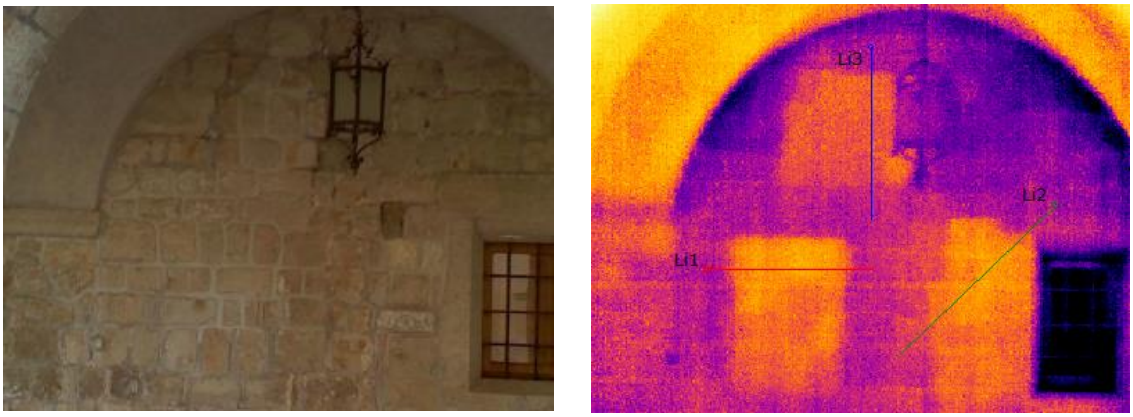


Figure 5.7. Comparison between the digital image and the image IR

The acquisition infrared highlighted, warmer areas than others, even if the difference of temperature is of the order of 1°C.

At the same time, the passive thermography was used to identify the weaving of masonry vaults (Figure 5.8a) and then confirm the assumptions made on the basis of existing literature and visual surveys.

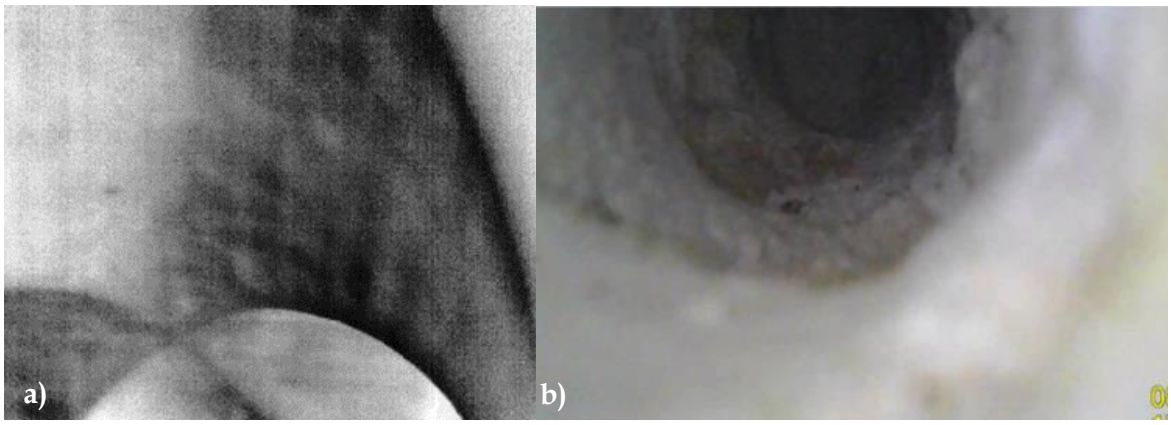


Figure 5. 8. a) IR image: vault in the portico of the Library; b) Endoscopy: vault in limestone

The vault was made of limestone with the elements arranged "*in foglio*". It is clear that the stone slabs have been put with the broader face tangent to the surface of soffit, and then cemented with mortar. A further confirmation about the type of construction was obtained from the information acquired during the endoscopic investigations carried out on other vaults (Figure 5.8b) present in the same complex.

5.6.4. Endoscopic Tests

The endoscopy allows direct visual inspection of cavities or other inaccessible parts inside the walls. By the insertion of a small endoscopic probe can be studied the hole surface to try to reconstruct the wall section and also the type of material present.

The analysis performed on different portions of masonry in the buildings of Carthusian monastery helped to identify the types of construction, also investigated by thermographic tests. This tests allowed to highlight the absence of voids in the wall section and also the absence of a core of the inner filling.

A digital inspection camera system has been used to conduct surveys of the wall sections. The system used has the following features a 3.5" full colour LCD Screen, a slim 8.2mm diameter probe with 6 adjustable LED lights, a high performance camera module with crystal clear output. and an integrated 1W CREE flash light for dark area working assistance.

Thanks to this type of analysis the structures have been classified on the basis of masonry classes identified in the bibliographical sources [48] consulted during the phase of knowledge of the structures.

The types of masonry identified are:

- *Masonry Class A1 - Group II*: masonry in irregular stone that combines the presence of the compact limestone also that of other materials (travertine stone and brick). This class of masonry is characterized by the disorder of the stone facing and for the presence of the connections realized with stone well-finished and larger (Figure 5.9).
- *Masonry Class A3 - Group I a*: masonry in compact limestone and mortar of lime and aggregates in limestone; with a homogeneous and undifferentiated texture. This class of masonry is characterized by the adjustment of the horizontality of set blocks at intervals more or less regular in height, and realized through the introduction of elements of particular size (Figure 5.10).
- *Masonry Class A3 - Group I a with "Ricorsi e listatura" (brick borders)*: masonry in compact limestone and mortar of lime and aggregates in limestone; with a homogeneous and undifferentiated texture. Differs from the previous for the presence of brick borders.
- *Masonry Class C - Group II a*: masonry that comes close to *opus quadratum*, generally *pseudoisodoma*. The stone blocks are perfectly square and rectangular with medium sizes.
- *Masonry Class C - Group III a/b*: masonry with exterior framework in limestone blocks perfectly squared, with large size blocks (h> 25 cm) or small to medium sized (h <20 cm); internal framework with blocks minimally processed and core made dry or compacted material.
- *Brickwork:* masonry characterized by the presence of solid brick in shape and regular texture. The various layers of brick are connected to each other by layers of mortar.

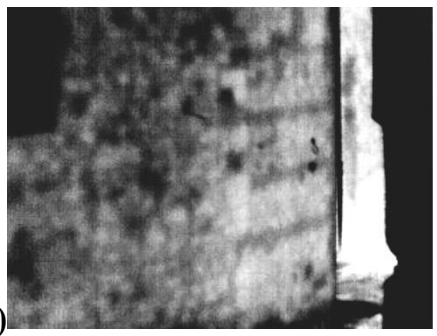
a)  **b)** 

Figure 5.9. a) Result of thermographic testing on the masonry Class A1 / II; b) endoscopy

a)  b) 

Figure 5.10. . a) Result of thermographic testing on the masonry Class A3 / Ia; b) endoscopy

5.6.5. Application of the survey protocol

The analysis of the Monastic Complex of Trisulti has allowed the study and application of the survey protocol described in section 5.2.

Such as for the case study of the museum complex of St. Chiara, according to the information collected and the analyses carried out, and with reference to the museum classification identified in §1.5, the Carthusian monastery of Trisulti (Figure 5.11) belongs to the *museums of art housed in spaces originally built for other destinations, with low rate of computerization and with spaces for the custody of the testimonies of the Carthusian life.*

Figure 5.11. General view of the Carthusian monastery of Trisulti

The main spaces are characterized by the presence of numerous frescoed wall surfaces and different paintings, works by important artists such as Filippo Balbi and Giuseppe Caci, furniture XVIII century decorating the Church of St. Bartholomew, the Refectory and the pharmacy, which happens to be the place of greatest interest to the presence within it not only of the original furniture but also ampoules and richly decorated majolica vases.

The Appendix reports the synthesis reports of the significant results obtained by the application of the survey protocol pertinent to different types of artistic assets exposed inside the monastic complex, differentiated for each Structural Organism and Structural Unit identified in the complex.

5.6.6. Some remarks

From the application of the survey protocol on movable heritage inside the Carthusian Monastery of Trisulti was possible to make several critical considerations regarding the degree of preservation of artworks exhibited and to acquire an adequate knowledge of the possible dynamic response and damage mechanisms of the different categories artworks, and it has been a useful support in the seismic vulnerability assessment of different structural units.

Church of St. Bartholomew

The barrel vault placed to cover the nave of the church, decorated with frescoes that represented the glory of Paradise by Giuseppe Caci, has large humidity stains caused by water damage from roof due to bad maintenance of these and a bad regimentation of rainwater.

There are traces of salt efflorescence (Figure 5.12) and loss of colour of the superficial finish (*intonachino*).

Figure 5.12. Frescoes by Giuseppe Caci, Church of St. Bartholomew

It is clear that the state of degradation, in the absence of timely interventions, could lead to loss of frescoes even before the occurrence of a seismic event.
The walls are, instead, decorated with paintings rectangular and oval made by Filippo Balbi during his stay in Trisulti. The presence of the painting of *I beati Laudavino e Guglielmo* inside the rooms of the Refectory (Figure 5.13) has allowed to understand the anchoring system of these to the support structure and then to evaluate the seismic response.

Figure 5.13. Filippo Balbi *I beati Laudavino e Guglielmo*

However, with the exception of some paintings which are more degraded, the state of preservation is remarkable, except for some loss of colour and stain.
What impresses the attention inside the Church are the two prestigious wooden choirs, both the chorus of the fathers, made between 1546 and 1548 the master Jacob, that one of the "conversi", made under the direction of fra Stefano between 1688 and 1690 by the carvers Uberto and Melchiorre of Arpino, with the collaboration of the master Andrea, carpenter of Alatri. During the application of the survey protocol there were not found specific degradation or alteration, except for some wear phenomenon anthropic not relevant. However it was possible to understand the anchoring system of the artwork to the building structures. It was found a particular framework, consists of a series fixed slats glued parallel to wood fibres and crossbeams inserted

perpendicularly, probably nailed to the wall masonry. This system, very similar to *parchettature* used in the restoration of paintings on wood, allows stabilizing the support and avoid movements caused by climate changes.

The Pharmacy of Trisulti

Amazing is the case of the frescoes in the Structural Organism of the Pharmacy (Figure 5.14). During compilation of the survey protocol were not observed particular forms of alteration and degradation, even after verification test for the presence of detachments of frescoed surfaces (finger-tapping). Extending the analysis and surveys to the entire artefact was emerged that the spaces below the Pharmacy showed a strong humidity and infiltrations with the consequent formation of a widespread biological patina.

The excellent state of preservation found is due both to recent restorations that the frescoes have undergone and the absence of alteration of the climatic conditions inside the building, therefore, should be planned maintenance of roof (which are heavily damaged) to ensure the protection and the preservation of the artworks exhibited.

Figure 5.14. The frescoes in the hallway of Pharmacy

The Refectory and the Chapter House

Between 1766 and 1770 is renewed, on the design of Tommaso Catrani, the image of the refectory. The rectangular hall of the refectory is covered with a barrel vault with lunettes of elliptical section which stands above a moulding in relief. Other mouldings and ornate stucco characterize the vault and the walls. Above the wooden backrests are positioned on one side, a painting of the *Moltiplicazione dei pani*, on the other a pulpit (Figure 5.15)

The hall has undergone several changes, later also to the interventions of 1936 provided for the Structural Organism following the earthquake in Avezzano 1915.

Figure 5.15. a) Project drawing; b) Refectory: *Moltiplicazione dei pani*

Currently there are humidity stains in the barrel vault, with consequent and limited detachment of *intonachino*. *"Lack"* have been detected in correspondence with the plaster frame of the painting, which, connected to the masonry by means of the metal elements clearly visible, does not present any form of alteration.

The construction of the new chapter house (Figure 5.16) was begun in 1637 and completed in 1639. The backrest in walnut, along the walls, includes thirty fixed seats, divided by grooved columns, surmounted by capitals of composite order or Tuscan, that support the overhanging cornice with linear and simple mouldings, it is the work of the engraver Domenico Busseto, working there from 1639 to 1640.

In the years 1788-1790 the painter Giacomo Manco recounted on canvas the story of Mary Magdalene, whose glorification is represented on the central vault of the chapter as a fresco. Of the paintings illustrating the main episodes of the life of Mary Magdalene remains only the altarpiece representing the *Penitent Magdalene in the Cave of Marseille*.

Figure 5.16. Chapter house: altar

Despite the Chapter House has lost its functions and is in a state of neglect, the state of preservation of artistic assets in it is exposed is not bad. The backrest, whose anchoring system to masonry walls is comparable to that of the wooden choir of the Church, presents mainly damage from wear anthropogenic.

The frescoes instead appear incomplete because of the fall colour, caused by phenomena of humidity and lack of maintenance consequent to the neglect of the space. There were also limited bulges with falling of plaster and the presence of salt efflorescence on the frescoed walls.

With regard to the canvas of the Maddalena, even if removed from its original location, does not present significant forms of alteration, however, for its current location, may be susceptible to sudden overturning with significant damage in during any seismic events.

6. Preservation and conservation in the context of the structural assessment.

6.1. Introduction

In the Guidelines [26], as widely emphasized in § 4.2, the Confidence Factor is introduced as the sum of four components linked to as many aspects arising from the path of knowledge and that link this to the prevention of the seismic risk.

Analysing the importance attributed to the partial coefficients of Confidence Factor, especially by performing the comparison with the previous version (2007), it appears that a significant contribution comes from the *Geometric Relief* (FC_1) and from the *Identification of the specificity historical and constructive of the building* (FC_2)

The importance of the *Geometry Relief* is associated to the accuracy with which the geometry of the artefact is represented in the actual spatial configuration, that is enriched by reading and restitution of the cracks described in the salient characteristics that qualify their position, size, and extension. In addition to this information also the trend of deformation state, out of plumb, bulging, differential settlement, help to assess possible damage mechanisms and to identify the exact position of the characteristic elements of the "box wall", like centres of gravity of the walls and of exact collocation of horizontal elements .

The *Identification of the historical and construction specificity of the building* represents the moment in which the direct observation of the construction and material features, historical investigations and considerations also morphological characters of architecture, in order to define a sequence of phases of construction of the building , are placed in relation to the mode of transformation that allow an interpretation of the structural behaviour, in terms of load sequences and changes of the structure resistant.

However, it happens very often that greater importance in the seismic assessment is given to the identification of *Mechanical properties of materials* (FC_3). Although these values are widely discussed in the literature and can be easily investigated through a critical reading of the literature sources collected during the historical investigation, with particular attention to those relating to the materials and construction techniques,

in the Guidelines is made extensive reference to the use of weakly destructive or destructive test, although on limited portions of the building, which consequently are used by technicians in order to resize the weight that FC_3 may have on the resulting value of FC.

From the analysis of the available sources and the results found in the case studies has been shown that the History, the geometrical relief including cracks, and the use of non-destructive tests, for the identification of the presence of a regular constructive, the aggregation mode of the elements that make up the masonry, connections of macro-elements and evaluation of the homogeneity of the different mechanical parameters in different parts of the buildings, excluding weakly destructive or destructive tests, provide the necessary information to the definition of interpretive models of the elements investigated, because a close relationship is established between knowledge of the transformations of the factory and of the state of damaging and methods for vulnerability assessment of a building. It appears clear, therefore, that a correct recognition of complex transformation of resistant system, associated to the identification of discontinuities and inhomogeneities constructive, related to the visible damage both caused by anthropogenic and other events, provide the essential elements for the assessment of the historical artefact, providing a valuable interpretive model of the building and pursuing the objective of conservation.

It is therefore proposed a compared analysis between the different types of testing (non-destructive, semi-destructive and destructive), focused primarily on the impact on the building, on the information obtained in relation to historical analysis and geometric of the building according to the level of assessment to be achieved.

6.2.Sustainability of tests

The study of the seismic vulnerability or the design of any restoration and renovation of a protected artefact should be preceded by an adequate knowledge of the artefact itself. This action is carried out through ordered and sequential acts, controllable and repeatable, that lead to the path of knowledge acquisition through a scientific method. Considerable importance, in the path of knowledge, is given to the analysis of materials and structures. This trend takes advantage of the aid of instrumental analysis that are performed on the same structures.

In the presence of assessments that invest assets of protected heritage, is necessary to pursue the safeguarding of the authenticity and value of the artwork examined, which are realized through the safeguarding of form and matter. For this reason, techniques for non-destructive testing are those that are most appropriate to the evaluation of materials, construction details and structures.

However, results from the application of NDT investigations can be fruitless if not properly framed within the historical analysis or the geometric or constructive survey. During the entire phase of the knowledge of the building, it is necessary that the results obtained from different fronts of investigation are compared among them to evaluate the reliability of the news and information and collected material. In addition, the integration of data and results allows important further information. From the comparison and integration of results it comes the need to direct the research in certain directions from which further elements can be found to complement the cognitive frameworks already identified. In this way it is possible, gradually, to make judgments both of critical type, on the cultural, historical and artistic value, of the building in its present form and of the parts that make it up today, and technical type, on structural characteristics and the conditions of vulnerability, both general that on particular areas. The collected data consent the availability of other important elaborate. First, it is possible to represent the successive phases of construction of the parts of the building, the changes and other interventions that are followed over time. The static schemes present in the different structures of the building can be identified, these schemes may even coincide with those originating in or derived from them as a result of changes in time. Knowing the characteristics of mechanical and morphological properties of structures, the vulnerability assessment or resistance assessment in response to any restoration can be performed.

It is in this context that one can propose a comparative analysis between the different types of testing (non-destructive, semi-destructive and destructive), focused primarily on the impact on the building, on the information obtained, on assessment levels and in relation to the types of analysis susceptible to implementation.

It aims to contribute to the planning and execution of investigation plans capable of ensuring adequate levels of analysis, but especially to limit the impact on the building protected.

The schematic description of performance, nature of the parameters obtained, impact on artwork and level of knowledge parameterised through the confidence factor FC, easily direct the attention of the operator on integrated strategies based on non-destructive testing, on all the experimental procedures that have a limited impact on the artwork and that then can be accomplished in a diffuse manner. The parameters which together allow to make an assessment of the sustainability of the different investigations are briefly described below.

The first parameter of evaluation that is the basis of the comparative framework is the type of investigation that may be performed on historical buildings with a masonry structure and from all analyses that must be performed a-priori, or the *Historical Analysis*, the *Relief Material*, the *Relief of the cracks and instabilities*, and that can be of support to the phase of knowledge, such as the compilation and the presence of a *Local and/or National Database*.

The next parameter concerns the *Type of support* that should be investigated. Therefore one can distinguish:

- masonry structures *in view*, in which is visible the texture of the facing;
- masonry structures *plastered*, for which it is assumed that the surface finish is without historical value or has been performed as a result of restoration that the artefact has recently undergone;
- masonry structures *decorated*, in which the surface finishing is characterized by the presence of frescoes or other decorative elements (stucco, plaster, ...) with significant historical, artistic and cultural value

On this parameter depends the *Impact on the artistic assets*, that is the impact that the investigation technique may have on the structure in relation to the kind of support that should be analysed. So we will have:

- *Null* impact, the application of the investigation will not affect the artistic assets;
- *Limited* impact, the investigation does not have significant consequences, and does not affect the conservation of the artistic assets;

- *Weakly invasive* impact, the application of the investigation doesn't have significant consequences but can have an impact on the conservation of the artistic assets;
- *Invasive* impact, the application of the investigation can have serious repercussions on the conservation of the artistic assets examined

The parameter related to *Role in knowledge for the restoration* highlights the way in which the information derived from the application of the tests can also be used in the design of interventions properly regarding the restoration, intending for it all interventions primarily aimed at conservation, to the recovery and to the valorisation of the different features of the building, in its architectural, historical and aesthetic aspects. Therefore, the information obtained, possibly made available by previous restoration or conservation of the artwork, should guide the choice of interventions mainly directed to the preservation of the typological, structural, formal and ornamental feature of the artwork and that are aimed at the same time to the cautious elimination of improper added and of superfetation that distort the meaning of art and the historical evidence of the artwork.

The information will be then:

- *Relevant*, if the analysis or the application of the tests provides relevant information in the context of knowledge of the state of preservation;
- *To evaluate*, if the analysis or the application of tests provides data that could have an impact on the level of knowledge of the state of preservation;
- *Not relevant*, if the analysis or the application of the tests provides irrelevant information in the context of the knowledge of the state of conservation.

The parameter relating to the *Role knowledge for seismic assessment* provides the type of information, to the evaluation of vulnerability, which can be derived from the application of the test on the structure, including not only information about the *Mechanical Parameters* or *Geometric Parameters* but also *Parameters of Preservation*, which provide information on the condition and deterioration of the artwork.

From the parameter related to the Diffusion of the investigations on the building is possible to deduce in what way investigations must be conducted on the artefact in view, especially, of the Level/Type of analysis that one wishes to pursue. Investigations can be conducted in a:

- *Limited,* on limited portions of the building and to complete of the information obtained from the literature*;*
- *Extended,* tests realized diffusely and systematically on the entire architectural complex*;*
- *To Avoid,* are the tests that directly affect the decorations regardless of the level / type of analysis.

The analysis phases and survey can be conducted, however, in order:

- *Exhaustive*, when known information concerning the artefact in all its parts;
- *Partial*, when known information concerning portions of the artefact.

The judgment expressed by the parameter *Sustainability of intervention for conservation* is linked to the fact that the survey is compatible, or sustainable, with representative values of the artistic asset, its preservation and its preservation. The predisposition of the investigation must be aimed at the conscious exploitation of the results from the investigations application. In fact, they must be able to give a response to the hypotheses already formulated and provide the physical and mechanical parameters to be used in assessments, through an appropriate data processing. The activity can then be:

- *Sustainable*, if the investigations are respectful towards the value of authenticity of the artwork, both in relation to the form that the matter of the artwork itself;
- *Not Sustainable*, if it is not safeguarded the value of the authenticity of the artwork;
- *If motivated and essential*, the application of the investigation cannot safeguard the authenticity of the artwork, but its implementation is essential for knowledge for structural assessment and for protection compared to external actions or environmental such as earthquake.

In parameter *Impact on FC* are identified which partial confidence factors are affected by the application of the various investigations, particularly with reference to the

Geometric Relief (FC_1), the *Identification of the specific historical and constructive of the building* (FC_2) and *Mechanical properties of materials* (FC_3).

The different types of investigations identified in the comparative framework, if properly combined, are able to provide information about the *volumetric, mechanical and dynamics characteristics* that enable you to implement models aimed at different analysis. The symbology adopted for the nature of the information available by the different types of tests is:

Nature of the information	D Direct	I Indirect	C Combined

where:

- *D*, information derived directly from the test;
- *I*, information derived indirectly from the test;
- *C*, information derived from the combination of several investigations and / or comparing information of the result of Historical analysis, Material Relief, Local and / or National Database.

The last parameter identified in the comparative framework, and that in a certain way guides the operator in the selection of the investigations to be carried out, concerns the *Level/Type of Analysis* to be reached. As regards the classification adopted for the type of analysis, in relation to the type of investigation, are identified:

- LV1 – qualitative analysis and assessment with simplified mechanical models;
- $LV2_{\infty}$ – analysis that can be conducted by assuming the infinite compressive strength of the masonry so one can avoid to proceed with invasive tests on structures to obtain experimental values of resistance;
- $LV2_R$ –analysis conducted making use of the characteristics of strength of masonry properly evaluated but considering, necessarily, the retraction of the plastic hinge;
- $LV3_{(L)}$ – assessment levels based on non-linear static Local analysis, therefore are extended LV2;
- $LV3_{(G)}$ – assessment levels based on Global analysis therefore require global models of building with the basic requirements in terms of box-like structure, regularity,

characteristics of horizontal structures, mechanical properties, etc.

In the following table, the parameters described above were evaluated for the different types of investigation performed. The synoptic framework provides concise but clear indication of the potential and critical issues of the different investigations; these, however, in turn will weighed with the specificities of the artwork to investigate in order to arrive at a judgment unique for each type.

With reference to the only aspect of sustainability for the conservation of the artistic assets, in the table are indicated in red activities that in some cases are not considered sustainable or would be carried out only when justified and essential.

Table 6.1. Comparative framework of investigation methods.

QUADRO COMPARATIVO DELLE PRESTAZIONI DELLE TECNICHE DI INDAGINE												
	Tipo di supporto	**Impatto sul bene**	**Ruolo nella conoscenza per il restauro**	**Ruolo nella conoscenza per la valutazione sismica**	**Diffusione delle indagini sulla costruzione**	**Sostenibilità dell'intervento per la conservazione**	**Impatto su FC**	**Massa Volumica**	**Tessitura**	**Resistenza**	**Rigidezza**	**Livello/Tipo di Analisi**
Prove soniche	A Vista	Nullo	Rilevante	Parametri Meccanici	Esteso	Sostenibile	FC_2		C	C	D	$LV2_{(R)}$-$LV3_{(L)}$
					Limitato	Sostenibile						$LV1$-$LV2_{(\infty)}$
Prove ultrasoniche	A Vista	Nullo	Rilevante	Parametri Meccanici	Esteso	Sostenibile	FC_2		C	C	D	$LV2_{(R)}$-$LV3_{(L)}$
					Limitato	Sostenibile						$LV1$-$LV2_{(\infty)}$
Termografia Passiva	Tutti	Nullo	Rilevante	Parametri Geometrici e di Conservazione	Esteso	Sostenibile	FC_2		D			TUTTI
Georadar	Tutti	Nullo	Rilevante	Parametri Geometrici	Esteso	Sostenibile	FC_2	C	C			TUTTI
Tiro Catene (Prova Dinamica)	A Vista	Nullo	Non Rilevante	Parametri Meccanici	Esteso	Sostenibile	FC_2				C	TUTTI
Prova Dinamica	A Vista/Intonacato	Nullo	Non Rilevante	Parametri Meccanici	Esteso	Sostenibile	FC_2				C	TUTTI
Endoscopia	A Vista/Intonacato	Limitato	Rilevante	Parametri Geometrici	Esteso	Sostenibile	FC_2	C	D	C	C	$LV2_{(R)}$-$LV3_{(L)}$
					Limitato	Sostenibile						$LV1$-$LV2_{(\infty)}$
Prove soniche	Intonacato	Limitato	Rilevante	Parametri Meccanici	Esteso	Sostenibile	FC_2		C	C	D	$LV2_{(R)}$-$LV3_{(L)}$
					Limitato	Sostenibile						$LV1$-$LV2_{(\infty)}$
Prove ultrasoniche	Intonacato	Limitato	Rilevante	Parametri Meccanici	Esteso	Sostenibile	FC_2		C	C	D	$LV2_{(R)}$-$LV3_{(L)}$
					Limitato	Sostenibile						$LV1$-$LV2_{(\infty)}$
Termografia Attiva	Decorato	Limitato	Rilevante	Parametri Geometrici e di Conservazione	Esteso	Sostenibile	FC_2		D			$LV2_{(R)}$-$LV3_{(L)}$
					Limitato	Sostenibile						$LV1$-$LV2_{(\infty)}$
Caratterizzazione malta	A Vista/Intonacato	Debolmente invasivo	Da Valutare	Parametri Meccanici	Esteso	Non Sostenibile	FC_3			D		$LV3_{(G)}$
					Limitato	Sostenibile						
Prove soniche	Decorato	Invasivo	Non Rilevante	Parametri Meccanici	Da Evitare	Non Sostenibile	FC_3		C	C	D	$LV3_{(G)}$
Prove ultrasoniche	Decorato	Invasivo	Non Rilevante	Parametri Meccanici	Da Evitare	Non Sostenibile	FC_3		C	C	D	$LV3_{(G)}$
Caratterizzazione blocco	A Vista/Intonacato	Invasivo	Non Rilevante	Parametri Meccanici	Esteso	Non Sostenibile	FC_3	I	D	I	I	$LV3_{(G)}$
					Limitato	Se motivato ed essenziale						
Martinetti singoli e/o doppi	A Vista/Intonacato	Invasivo	Non Rilevante	Parametri Meccanici	Esteso	Non Sostenibile	FC_3			D	D	$LV3_{(G)}$
					Limitato	Se motivato ed essenziale						
Prova scorrimento giunti malta	A Vista/Intonacato	Invasivo	Non Rilevante	Parametri Meccanici	Esteso	Non Sostenibile	FC_3			D		$LV3_{(G)}$
					Limitato	Se motivato ed essenziale						
Saggi demolitivi	A Vista/Intonacato	Invasivo	Da Valutare	Parametri Geometrici	Esteso	Non Sostenibile	FC_3	I	D	C	C	$LV3_{(G)}$
					Limitato	Se motivato ed essenziale						
Carotaggi	A Vista/Intonacato	Invasivo	Non Rilevante	Parametri Geometrici	Esteso	Non Sostenibile	FC_3	D	D	C	C	$LV3_{(G)}$
					Limitato	Se motivato ed essenziale						
Analisi storica	–	Nullo	Rilevante	Parametri Geometrici, di Conservazione, Meccanici	Esaustivo	Sostenibile	FC_2	C	C			TUTTI
					Parziale	Sostenibile						
Rilievo Materico	–	Nullo/Limitato	Rilevante	Parametri Geometrici, di Conservazione, Meccanici	Esaustivo	Sostenibile	FC_2	C	D	D	D	TUTTI
					Parziale	Sostenibile						
Quadro fessurativo e dei dissesti	–	Nullo	Rilevante	Parametri Geometrici e di Conservazione	Esaustivo	Sostenibile	FC_1/FC_2		C	C	C	TUTTI
					Parziale	Sostenibile						
Database Locali e/o Nazionale	–	Nullo	–	Parametri Meccanici	–	–	FC_2	C	D	D	D	TUTTI

Natura dell'informazione	D	I	C
	Diretta	Indiretta	Combinata

In conclusion, the predisposition of an investigations plan must be part of the process of knowledge of structural consistency of an Architectural Complex (CA) as a useful corollary of interpretive hypothesis held during the historical-archival.

This comparative framework is the result of the analysis of the results obtained by different research units as part of MiBAC-ARCUS "Analysis of the seismic vulnerability of the state museums" research project

7. Conclusions

The aim of this dissertation was the development of a fast and effective survey protocol for protected cultural heritage, for the systematic and rational collection of data related to the typological characteristics and the level of potential damage of artistic heritage in a seismic context.

In National Guidelines for structural assessment often emerges the importance that the path of knowledge takes in the seismic vulnerability assessment, and particular attention is given not only on historical building but also on movable heritage, in a broad view of "container and content". Similarly, approaching to the conservative restoration is defined a systematic-scientific method that traces the entire history of the building to ensure its preservation with the itself intervention of restore.

From the review of the technical framework, it is clear that the movable heritage has a secondary role compared with the artwork "container", although it was introduced Artistic Limit State exactly in the Guidelines. Some studies in the past have focused on strategies for intervention planning for the protection of museum goods, with reflections related also to the seismic action response. Recently, new research projects have been developed due to the increased sensitivity to these issues. However, the study of artistic assets lacking support to the knowledge phase, unlike the immovable property and the masonry structures.

The purpose of the implementation of a valid support in the phase of knowledge of heritage, through a guided and reasoned path in the collection of geometric information and related to the conservation state, was achieved through a critical and comparative analysis of tools currently available in the technical literature, or those implemented and used in past seismic crisis. This presents a very simple implementation. The results, obtained from surveys conducted on the eighteenth-century monumental complex of S. Chiara in Naples, confirm a certain simplicity and speed of information collection and appreciable flexibility that makes the data structure compatible with the use of any kind of artistic heritage, and delineate also a scenario comforting about the validity of the protocol in accordance of the high number and different types of cultural assets surveyed.

In the project MiBAC-ARCUS "Analysis of the seismic vulnerability of the state museums", it was possible to make accurate investigations into the thirteenth Carthusian Monastery of Trisulti which involved not only exhibited heritage, but also the buildings "containers". The results have confirmed the simplicity and flexibility of the survey protocol on the movable heritage. In addition some critical considerations were made on the techniques of investigation provided by the Guidelines as part of the seismic vulnerability assessment of historic buildings. The application of destructive tests methods destructive could compromise conservation of cultural heritage. It is therefore obvious that the non-destructive test methods should be preferred and assist the path of knowledge through the draft of a thorough investigation plan.

The diagnostic approach to the monument, often defined a priori as a standard protocol of what is required to do to reach a definition of certain parameters necessary for further evaluation of the structural characteristics of the object in question, must result from an accurate reflection criticism.

The definition of the investigation plan to propose and share with who has in charge of the protection of the building and management of the CA, is in fact a piece of the path of knowledge that proceeds in parallel with the deepening of the other survey instruments used, like the visual investigation, the archival and literature research, the consulting in the archives of projects and contractual documents of work performed. Therefore **the campaign of diagnostic tests** must be understood as a complementary tool of the latter, and **be developed** on the basis of the results achieved during the process of knowledge already performed, **in phase of next study in which the extension of the testing campaign is proportional to sustainability of the type of the proposed trial**.

Appendix A: the museum complex of Santa Chiara in Naples

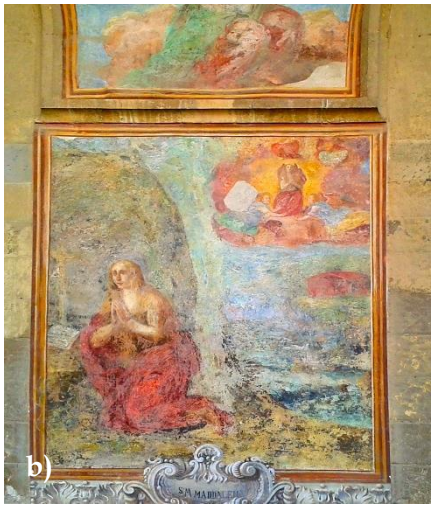


Figure A.1.a) Frescoes of west walkway; **b)** Detail: the Magdalene

Table A.1. Sheet "Frescoes of the Museum Complex of St. Chiara": Identification of the artwork

Identification of the artwork						
Object	Frescoes of the Museum Complex of St. Chiara, Naples					
Subject	Scenes from the Old Testament; Saints, Allegories; Virtue					
Author	Unknown					
Cultural Context	Bellissario Corenzio Shool					
Chronology	year 1600 circa		century XVII		era	
Position	Church	√	Museum room	□	Palace	□
	Outdoor spaces	√	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	√	Wall sx	√	Lunette dx	√
	Lunette sx	√	Vault	√	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	□

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	850				800			
Tipologia	Amovibile			□	Inamovibile			√
	Opera isolata			□	Serie			√
	Frammento			□	Altro			□
	Note							
Precedenti restauri	Interventi documentati			√	Interventi non documentati			□
	Note: Gli affreschi presenti negli ambulacri hanno subito due interventi significativi, il primo tra il 1766/1769 ad opera di Gennaro Pierro e Filippo Galietti, il secondo tra il 1998/2001. Tali interventi hanno interessato l'intero chiostro maiolicato							
	Rifacimenti/Aggiunte	1766/1769			1998/2001			
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	√	Cavi elettrici	□
	Note: Con gli interventi eseguiti tra il 1998/2001 sono stati riportati alla luce parte degli affreschi '600 occultati dall'intervento di Perro e Galietti							

CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC.
	Affreschi	√	4	68 m^2	Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	□		
	Arazzi	□			Arredi	□		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		

MATERIALI								
STRUTTURE DI SOSTEGNO	Fisse	√	Mobili	□	Sospese	□		
	Vetrina	□	Cavalletto	□	Mensola	□		
	Bacheca	□	Piedistallo	□	Soffitto	√		
	Parete	√	Pavimento	□	Pannello	□		
	Scaffalatura	□	Rastrelliera	□	Altro	□		
	Note							
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	□	Telaio	□	Chiodi	□		
	Corde o fili metallici	□	Base murale	√	Parchettature	□		
	Altro						□	
SUPPORTO	Tela	□	Legno	□	Metallo	□		
	Vetro	□	Carta	□	Pietra	□		
	Cuoio	□	Pergamena	□	Intonaco/Muratura	√		
STRATI PREPARATORI	Gesso	□	Intonaco	√	Colla	□		
PELLICOLA PITTORICA	Dipinti a olio	□	Dipinti a tempera	√	Acquerelli	□		

Classificazione dell'opera

Classificazione dell'opera in base alla tipologia

T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	□	Statue, sculture e grandi vasi
T4	□	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	√	Altro

Classificazione dell'opera in base alla tipologia del supporto

	A				B	C		D
	Oggetti poggiati su una superficie piana				Oggetti fissati su un piedistallo	Oggetti appesi o sospesi		Altro
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	su mensole o all'interno di bacheche		appesi ad una parete	sospesi al soffitto	
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	-	*	-	-	-
T4	-	-	-	-	-	*	-	*
T5	-	-	-	-	-	-	*	-
T6	*	*	*	*	*	*	*	*

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte

Categoria	Modalità di risposta		Meccanismi di danno		Sigla
A	moto attaccato	□	sollecitazioni eccessive	□	R1
	Scivolamento	□	spostamenti eccessivi	□	R2
	Oscillazioni	□	urti ripetuti	□	R3
	Oscillazioni	□	ribaltamento	□	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	Oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	□	sollecitazioni eccessive	□	R1
	moto attaccato	□	spostamenti eccessivi	□	R2
	moto attaccato	√	ribaltamento	√	R4

STATO DI CONSERVAZIONE GENERALE DELL'OPERA								
Buono	□	Discreto	√	Scadente	□	Pessimo	□	

STATO DI CONSERVAZIONE DELL'OPERA								
AFFRESCHI								
INTONACO	Distacco	√	Rigonfiamento	□	Disgregazione	□		
	Deposito superficiale	□	Caduta	√	Lesioni	√		
	Fessurazioni	□	Lacune	√	Macchie di umidità	□		
	Mancanza	√	Efflorescenza salina	√	Altro	□		
PELLICOLA PITTORICA	Decoesione	□	Macchie di umidità	□	Polverizzazione	□		
	Caduta di colore	√	Patina biologica	√	Distacchi a scaglie	√		
	Altro						□	

Figure A.2.a) Seats in majolica; **b)** Details

Table A.2. Sheet "Seats in majolica of the Museum Complex of St. Chiara": Identification of the artwork

Identification of the artwork						
Object	Seats in majolica of the Museum Complex of St. Chiara; Naples					
Subject **Author**	Representations of daily life related to rural world of farmers; hunting scenes; mythological scenes and masks taken from the comedy of art; scenes of entertainment and game					
Cultural Context	Domenico Antonio Vaccaro; Donato e Giuseppe Massa					
Chronology						
Position	year 1739		century		era	
Specific Location	Church	□	Museum room	□	Palace	□
	Outdoor spaces	√	Street/Square	□	Archaeological site	□
	Wall dx	□	Wall sx	□	Lunette dx	□
	Lunette sx	□	Vault	□	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	√

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	130		55		400			
Tipologia	Amovibile		□		Inamovibile		√	
	Opera isolata		□		Serie		√	
	Frammento		□		Altro		□	
	Note							
Precedenti restauri	Interventi documentati		√		Interventi non documentati		□	
	Note: Intervento 1998/2001 che ha interessato l'intero chiostro maiolicato							
	Rifacimenti/Aggiunte	**1998/2001**						
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	√	Cavi elettric	□
	Note: Sono state recuperate gran parte delle maioliche che presentavano danni causati da umidità di risalita							

CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC.
	Affreschi	□			Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	□		
	Arazzi	□			Arredi	√		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		

MATERIALI							
STRUTTURE DI SOSTEGNO	Fisse	√	Mobili	□	Sospese	□	
	Vetrina	□	Cavalletto	□	Mensola	□	
	Bacheca	□	Piedistallo	□	Soffitto	□	
	Parete	□	Pavimento	√	Pannello	□	
	Scaffalatura	□	Rastrelliera	□	Altro	□	
	Note						
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	□	Telaio	□	Chiodi	□	
	Corde o fili metallici	□	Base murale	√	Parchettature	□	
	Altro					□	
SUPPORTO	Tela	□	Legno	□	Metallo	□	
	Vetro	□	Carta	□	Pietra	√	
	Cuoio	□	Pergamena	□	Intonaco/Muratura	□	

Classificazione dell'opera		
Classificazione dell'opera in base alla tipologia		
T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	□	Statue, sculture e grandi vasi
T4	□	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	√	Altro

Classificazione dell'opera in base alla tipologia del supporto

	A				B	C		D
	Oggetti poggiati su una superficie piana				Oggetti fissati su un piedistallo	Oggetti appesi o sospesi		Altro
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	su mensole o all'interno di bacheche		appesi ad una parete	sospesi al soffitto	
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	-	*	-	-	-
T4	-	-	-	-	-	*	-	*
T5	-	-	-	-	-	-	*	-
T6	*	*	*	*	*	*	*	*

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte

Categoria	Modalità di risposta		Meccanismi di danno		Sigla
A	moto attaccato	□	sollecitazioni eccessive	□	R1
	Scivolamento	□	spostamenti eccessivi	□	R2
	Oscillazioni	□	urti ripetuti	□	R3
	Oscillazioni	□	ribaltamento	□	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	Oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	□	sollecitazioni eccessive	√	R1
	moto attaccato	□	spostamenti eccessivi	□	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA								
Buono	√	Discreto	□	Scadente	□	Pessimo	□	

STATO DI CONSERVAZIONE DELL'OPERA								
PRODOTTI IN CERAMICA								
SUPPORTO	Fessurazioni	□	Mancanza	√	Distacco del rivestiment	√		
	Polverizzazione	□	Depositi superficiali	□	Patina	□		
	Esfoliazione	□	Efflorescenze saline	√	Croste	□		
	Macchie	□	Altro			□		
RIVESTIMENTO	Esfoliazione	□	Polverizzazione	□	Mancanza	□		
	Macchie di umidità	√	Depositi superficiali	□	Lacune	√		
	Decoesione	□	Caduta di colore	□	Distacco	√		
	Patina biologica	□	Altro			□		

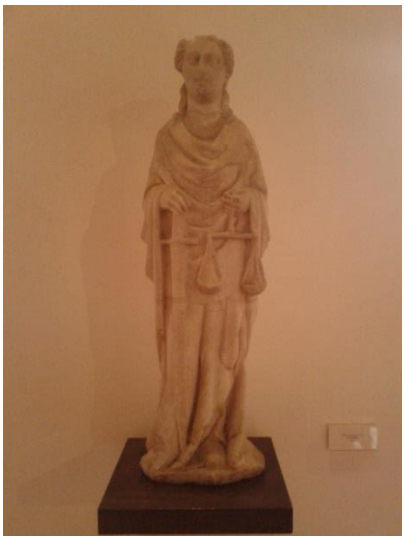


Figure A.3. The Justice, Unknown Neapolitan sculptor

Table A.3. Sheet "The Justice": Identification of the artwork

Identification of the artwork						
Object	Marble statue					
Subject	The Justice					
Author	Unknown Neapolitan sculptor					
Cultural Context						
Chronology	year		century XIV		era	
Position	Church	□	Museum room	√	Palace	□
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	√	Wall sx	□	Lunette dx	□
	Lunette sx	□	Vault	□	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	□

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	85				25			
Tipologia	Amovibile			√	Inamovibile			□
	Opera isolata			□	Serie			√
	Frammento			□	Altro			□
	Note							
Precedenti restauri	Interventi documentati			√	Interventi non documentati			□
	Note: Intervento 1998/2000 in occasione del nuovo allestimento museale							
	Rifacimenti/Aggiunte							
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	□	Cavi elettric	□
	Note: Non presenti							

CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC.
	Affreschi	□			Altari/Statue	√		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	□		
	Arazzi	□			Arredi	□		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		

MATERIALI								
STRUTTURE DI SOSTEGNO	Fisse	□	Mobili	□	Sospese	√		
	Vetrina	□	Cavalletto	□	Mensola	√		
	Bacheca	□	Piedistallo	□	Soffitto	□		
	Parete	□	Pavimento	□	Pannello	□		
	Scaffalatura	□	Rastrelliera	□	Altro	□		
	Note							
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	□	Telaio	□	Chiodi	□		
	Corde o fili metallici	□	Base murale	√	Parchettature	□		
	Altro					□		
SUPPORTO	Tela	□	Legno	√	Metallo	□		
	Vetro	□	Carta	□	Pietra	□		
	Cuoio	□	Pergamena	□	Intonaco/Muratura	□		
Misure del supporto [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Altezza da terra [h]**	
	5		45		35		110	

Coefficiente d'attrito - Superficie materiali					
Alluminio su formica	0,12	Teflon su mosaico	0,10	Plexiglass su vetro	0,20
Marmo su formica	0,18	Alluminio su legno	0,37	Plexiglass su teflon	0,15
Teflon su formica	0,13	Alluminio su alluminio	0,24	Teflon su vetro	0,13
Alluminio su mosaico	0,20	Alluminio su teflon	0,23	Terracotta su plexiglass	0,30
Marmo su mosaico	0,13	Plexiglass su plexiglass	0,35	Terracotta su vetro	0,30

Classificazione dell'opera		
Classificazione dell'opera in base alla tipologia		
T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	√	Statue, sculture e grandi vasi
T4	□	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	□	Altro

Classificazione dell'opera in base alla tipologia del supporto

	A				B	C		D
	Oggetti poggiati su una superficie piana				Oggetti fissati su un piedistallo	Oggetti appesi o sospesi		Altro
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	su mensole o all'interno di bacheche		appesi ad una parete	sospesi al soffitto	
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	√	*	-	-	-
T4	-	-	-	-	-	*	-	*
T5	-	-	-	-	-	-	*	-
T6	*	*	*	*	*	*	*	*

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte

Categoria	Modalità di risposta		Meccanismi di danno		Sigla
A	moto attaccato	□	sollecitazioni eccessive	□	R1
	Scivolamento	□	spostamenti eccessivi	□	R2
	Oscillazioni	□	urti ripetuti	□	R3
	Oscillazioni	√	ribaltamento	√	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	Oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	□	sollecitazioni eccessive	□	R1
	moto attaccato	□	spostamenti eccessivi	□	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	√	Discreto	□	Scadente	□	Pessimo	□

STATO DI CONSERVAZIONE DELL'OPERA							
SCULTURE, ALTORILIEVI, BASSORILIEVI IN PIETRA							
SUPPORTO	Lesioni	□	Depositi superficiali	□	Croste	□	
	Distacchi	□	Alterazione cromatica	□	Degradazione differ.le	□	
	Disgregazione	□	Erosione	□	Esfoliazione	□	
	Incrostazione	□	Macchia	□	Mancanza	√	
	Patina	□	Pellicola	□	Pitting	□	
	Polverizzazione	□	Altro			□	

Figure A.4. Bas-relief with coat of arms, Neapolitan artists

Table A.4. Sheet "Bas-relief with coat of arms": Identification of the artwork

Identification of the artwork						
Object	Bas-relief with coat of arms					
Subject	Fragment of the railing of the terraces of the cells of the Clares					
Author	Neapolitan artists					
Cultural Context						
Chronology	year		century XVI-XVII		era	
Position	Church	□	Museum room	√	Palace	□
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	□	Wall sx	√	Lunette dx	□
	Lunette sx	□	Vault	□	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	□

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	60		13		40			
Tipologia	Amovibile			□	Inamovibile			□
	Opera isolata			□	Serie			□
	Frammento			√	Altro			□
	Note							
Precedenti restauri	Interventi documentati			√	Interventi non documentati			□
	Note							
	Rifacimenti/Aggiunte							
	Fori	□	Chiodi	□	Viti	□	Grappe	√
	Staffe	√	Schizzi	□	Stuccature	□	Cavi elettrici	□
	Note							

CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC.
	Affreschi	□			Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	□		
	Arazzi	□			Arredi	√		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		

MATERIALI						
STRUTTURE DI SOSTEGNO	Fisse	√	Mobili	□	Sospese	□
	Vetrina	□	Cavalletto	□	Mensola	√
	Bacheca	□	Piedistallo	□	Soffitto	□
	Parete	□	Pavimento	□	Pannello	□
	Scaffalatura	□	Rastrelliera	□	Altro	□
	Note					
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	√	Telaio	□	Chiodi	□
	Corde o fili metallici	□	Base murale	√	Parchettature	□
	Altro					□
SUPPORTO	Tela	□	Legno	□	Metallo	√
	Vetro	□	Carta	□	Pietra	□
	Cuoio	□	Pergamena	□	Intonaco/Muratura	□
Misure del supporto [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**	**Diametro [D]**
	130		20		35	5

Coefficiente d'attrito - Superficie materiali					
Alluminio su formica	0,12	Teflon su mosaico	0,10	Plexiglass su vetro	0,20
Marmo su formica	0,18	Alluminio su legno	0,37	Plexiglass su teflon	0,15
Teflon su formica	0,13	Alluminio su alluminio	0,24	Teflon su vetro	0,13
Alluminio su mosaico	0,20	Alluminio su teflon	0,23	Terracotta su plexiglass	0,30
Marmo su mosaico	0,13	Plexiglass su plexiglass	0,35	Terracotta su vetro	0,30

Classificazione dell'opera		
Classificazione dell'opera in base alla tipologia		
T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	√	Statue, sculture e grandi vasi
T4	□	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	□	Altro

Classificazione dell'opera in base alla tipologia del supporto

	A				B	C		D
	Oggetti poggiati su una superficie piana				Oggetti fissati su un piedistallo	Oggetti appesi o sospesi		Altro
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	su mensole o all'interno di bacheche		appesi ad una parete	sospesi al soffitto	
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	-	*	-	-	√
T4	-	-	-	-	-	*	-	*
T5	-	-	-	-	-	-	*	-
T6	*	*	*	*	*	*	*	*

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte

Categoria	Modalità di risposta		Meccanismi di danno		Sigla
A	moto attaccato	□	sollecitazioni eccessive	□	R1
	Scivolamento	□	spostamenti eccessivi	□	R2
	Oscillazioni	□	urti ripetuti	□	R3
	Oscillazioni	□	ribaltamento	□	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	Oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	√	sollecitazioni eccessive	√	R1
	moto attaccato	□	spostamenti eccessivi	□	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	√	Discreto	□	Scadente	□	Pessimo	□
STATO DI CONSERVAZIONE DELL'OPERA							
SCULTURE, ALTORILIEVI, BASSORILIEVI IN PIETRA							
SUPPORTO	Lesioni	□	Depositi superficiali	□	Croste	□	
	Distacchi	□	Alterazione cromatica	□	Degradazione differ.le	□	
	Disgregazione	□	Erosione	√	Esfoliazione	□	
	Incrostazione	□	Macchia	□	Mancanza	√	
	Patina	□	Pellicola	□	Pitting	□	
	Polverizzazione	□	Altro			□	

Figure A.5. Pulpit: marble lions, Neapolitan sculptor

Table A.5. Sheet "Pulpit: marble lions": Identification of the artwork

Identification of the artwork						
Object	Pulpit					
Subject	Marble lions					
Author	Neapolitan sculptor					
Cultural Context						
Chronology	year 1345 circa		century XIV		era	
Position	Church	□	Museum room	√	Palace	□
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	□	Wall sx	□	Lunette dx	□
	Lunette sx	□	Vault	□	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	√

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	50		28		65			
Tipologia	Amovibile	□			Inamovibile			□
	Opera isolata	□			Serie			√
	Frammento	□			Altro			□
	Note							
Precedenti restauri	Interventi documentati	√			Interventi non documentati			□
	Note							
	Rifacimenti/Aggiunte							
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	□	Cavi elettric	□
	Note							

CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC.
	Affreschi	□			Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	□		
	Arazzi	□			Arredi	√		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		

MATERIALI							
STRUTTURE DI SOSTEGNO	Fisse	□	Mobili	√	Sospese	□	
	Vetrina	□	Cavalletto	□	Mensola	□	
	Bacheca	□	Piedistallo	□	Soffitto	□	
	Parete	□	Pavimento	√	Pannello	□	
	Scaffalatura	□	Rastrelliera	□	Altro	□	
	Note						
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	□	Telaio	□	Chiodi	□	
	Corde o fili metallici	□	Base murale	□	Parchettature	□	
	Altro					□	
SUPPORTO	Tela	□	Legno	√	Metallo	□	
	Vetro	□	Carta	□	Pietra	□	
	Cuoio	□	Pergamena	□	Intonaco/Muratura	□	
Misure del supporto [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	5		40		81			

Coefficiente d'attrito - Superficie materiali					
Alluminio su formica	0,12	Teflon su mosaico	0,10	Plexiglass su vetro	0,20
Marmo su formica	0,18	Alluminio su legno	0,37	Plexiglass su teflon	0,15
Teflon su formica	0,13	Alluminio su alluminio	0,24	Teflon su vetro	0,13
Alluminio su mosaico	0,20	Alluminio su teflon	0,23	Terracotta su plexiglass	0,30
Marmo su mosaico	0,13	Plexiglass su plexiglass	0,35	Terracotta su vetro	0,30

Classificazione dell'opera		
Classificazione dell'opera in base alla tipologia		
T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	√	Statue, sculture e grandi vasi
T4	□	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	□	Altro

Classificazione dell'opera in base alla tipologia del supporto								
	A				**B**		**C**	**D**
	Oggetti poggiati su una superficie piana				Oggetti fissati su un piedistallo		Oggetti appesi o sospesi	Altro
	A1	A2	A3	A4			C2	C2
	sul pavimento	su di un piedistallo	all'interno di vetrine	su mensole o all'interno di bacheche			appesi ad una parete	sospesi al soffitto
T1	*	*	*	*	*		-	-	-
T2	*	*	*	*	*		-	-	-
T3	√	*	-	-	*		-	-	-
T4	-	-	-	-	-		*	-	*
T5	-	-	-	-	-		-	*	-
T6	*	*	*	*	*		*	*	*

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte					
Categoria	**Modalità di risposta**		**Meccanismi di danno**		**Sigla**
A	moto attaccato	□	sollecitazioni eccessive	□	R1
	Scivolamento	√	spostamenti eccessivi	√	R2
	Oscillazioni	□	urti ripetuti	□	R3
	Oscillazioni	□	ribaltamento	□	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	Oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	□	sollecitazioni eccessive	□	R1
	moto attaccato	□	spostamenti eccessivi	□	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	√	Discreto	□	Scadente	□	Pessimo	□

STATO DI CONSERVAZIONE DELL'OPERA							
SCULTURE, ALTORILIEVI, BASSORILIEVI IN PIETRA							
SUPPORTO	Lesioni	√	Depositi superficiali	□	Croste	□	
	Distacchi	□	Alterazione cromatica	□	Degradazione differ.le	□	
	Disgregazione	□	Erosione	□	Esfoliazione	□	
	Incrostazione	□	Macchia	□	Mancanza	√	
	Patina	□	Pellicola	□	Pitting	□	
	Polverizzazione	□	Altro			□	

Figure A.6. Wood carvings, Neapolitan Unknown

Table A.5. Sheet "Wood carvings": Identification of the artwork

Identification of the artwork						
Object	Wood carvings					
Subject	Ecce Homo; S. Giovanni Evangelista					
Author	Neapolitan Unknown					
Cultural Context						
Chronology	year		century XVIII-XIX		era	
Position	Church	□	Museum room	√	Palace	□
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	□	Wall sx	√	Lunette dx	□
	Lunette sx	□	Vault	□	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	□

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
Tipologia	Amovibile			□	Inamovibile			□
	Opera isolata			√	Serie			□
	Frammento			□	Altro			□
	Note							
Precedenti restauri	Interventi documentati			√	Interventi non documentati			□
	Note							
	Rifacimenti/Aggiunte		**1998/2000**					
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	□	Cavi elettric	□
	Note							

CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC.
	Affreschi	□			Altari/Statue	√		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	□		
	Arazzi	□			Arredi	□		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		

MATERIALI								
STRUTTURE DI SOSTEGNO	Fisse	□	Mobili	√	Sospese	□		
	Vetrina	□	Cavalletto	□	Mensola	□		
	Bacheca	□	Piedistallo	√	Soffitto	□		
	Parete	□	Pavimento	□	Pannello	□		
	Scaffalatura	□	Rastrelliera	□	Altro	□		
	Note							
SUPPORTO	Tela	□	Legno	√	Metallo	□		
	Vetro	□	Carta	□	Pietra	□		
	Cuoio	□	Pergamena	□	Intonaco/Muratura	□		
Misure del supporto [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	111		60		93			

Coefficiente d'attrito - Superficie materiali					
Alluminio su formica	0,12	Teflon su mosaico	0,10	Plexiglass su vetro	0,20
Marmo su formica	0,18	Alluminio su legno	0,37	Plexiglass su teflon	0,15
Teflon su formica	0,13	Alluminio su alluminio	0,24	Teflon su vetro	0,13
Alluminio su mosaico	0,20	Alluminio su teflon	0,23	Terracotta su plexiglass	0,30
Marmo su mosaico	0,13	Plexiglass su plexiglass	0,35	Terracotta su vetro	0,30

Classificazione dell'opera		
Classificazione dell'opera in base alla tipologia		
T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	√	Statue, sculture e grandi vasi
T4	□	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	□	Altro

Classificazione dell'opera in base alla tipologia del supporto

	A				B	C		D
	Oggetti poggiati su una superficie piana					Oggetti appesi o sospesi		Altro
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	su mensole o all'interno di bacheche	Oggetti fissati su un piedistallo	appesi ad una parete	sospesi al soffitto	
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	√	-	-	*	-	-	-
T4	-	-	-	-	-	*	-	*
T5	-	-	-	-	-	-	*	-
T6	*	*	*	*	*	*	*	*

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte

Categoria	Modalità di risposta		Meccanismi di danno		Sigla
A	moto attaccato	□	sollecitazioni eccessive	□	R1
	Scivolamento	√	spostamenti eccessivi	√	R2
	Oscillazioni	□	urti ripetuti	□	R3
	Oscillazioni	√	ribaltamento	√	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	Oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	□	sollecitazioni eccessive	□	R1
	moto attaccato	□	spostamenti eccessivi	□	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	√	Discreto	□	Scadente	□	Pessimo	□

STATO DI CONSERVAZIONE DELL'OPERA							
SCULTURE, ALTORILIEVI, BASSORILIEVI IN LEGNO							
SUPPORTO	Aggressione da insetti	□	Deformazione	□	Mancanze (mutilazioni)	√	
	Bruciature	□	Marcescenza	□	Macchie di umidità	□	
	Altro					□	
PELLICOLA PITTORICA	Caduta di colore	√	Distacco	□	Decoesione	□	
	Polverizzazione	□	Depositi superficiali	□	Tracce di bruciature	□	
	Lacune	√	Efflorescenza	□	Integrazioni	√	
	Altro					□	

Figure A.7. Fragment of the columns of the ciborium: capital, Sculptor Unknown

Table A.7. Sheet "Fragment of the columns of the ciborium: capital": Identification of the artwork

Identification of the artwork						
Object	Fragment of the columns of the ciborium: capital					
Subject	Female heads and eagles with spread wings					
Author	Sculptor Unknown					
Cultural Context						
Chronology	year 1240 circa		century XIII	era		
Position	Church	□	Museum room	√	Palace	□
	Outdoor spaces	□	Street/Square	□	Archaeological site	□

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	50						30	
Tipologia	Amovibile			□	Inamovibile			□
	Opera isolata			□	Serie			□
	Frammento			√	Altro			□
	Note							
Precedenti restauri	Interventi documentati			√	Interventi non documentati			□
	Note							
	Rifacimenti/Aggiunte		**1998/2000**					
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	□	Cavi elettric	□
	Note							
CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC.
	Affreschi	□			Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	□		
	Arazzi	□			Arredi	√		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		
MATERIALI								
STRUTTURE DI SOSTEGNO	Fisse	□	Mobili		√	Sospese	□	
	Vetrina	□	Cavalletto		□	Mensola	□	
	Bacheca	□	Piedistallo		√	Soffitto	□	
	Parete	□	Pavimento		□	Pannello	□	
	Scaffalatura	□	Rastrelliera		□	Altro	□	
	Note							
Misure del supporto [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	120						35	

Coefficiente d'attrito - Superficie materiali					
Alluminio su formica	0,12	Teflon su mosaico	0,10	Plexiglass su vetro	0,20
Marmo su formica	0,18	Alluminio su legno	0,37	Plexiglass su teflon	0,15
Teflon su formica	0,13	Alluminio su alluminio	0,24	Teflon su vetro	0,13
Alluminio su mosaico	0,20	Alluminio su teflon	0,23	Terracotta su plexiglass	0,30
Marmo su mosaico	0,13	Plexiglass su plexiglass	0,35	Terracotta su vetro	0,30

Classificazione dell'opera		
Classificazione dell'opera in base alla tipologia		
T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	√	Statue, sculture e grandi vasi
T4	□	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	□	Altro

Classificazione dell'opera in base alla tipologia del supporto

	A				B	C		D
	Oggetti poggiati su una superficie piana					Oggetti appesi o sospesi		Altro
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	su mensole o all'interno di bacheche	Oggetti fissati su un piedistallo	appesi ad una parete	sospesi al soffitto	
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	√	-	-	*	-	-	-
T4	-	-	-	-	-	*	-	*
T5	-	-	-	-	-	-	*	-
T6	*	*	*	*	*	*	*	*

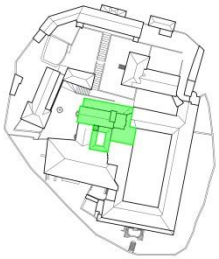
Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte

Categoria	Modalità di risposta		Meccanismi di danno		Sigla
A	moto attaccato	□	sollecitazioni eccessive	□	R1
	Scivolamento	√	spostamenti eccessivi	√	R2
	Oscillazioni	□	urti ripetuti	□	R3
	Oscillazioni	√	ribaltamento	√	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	Oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	□	sollecitazioni eccessive	□	R1
	moto attaccato	□	spostamenti eccessivi	□	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	√	Discreto	□	Scadente	□	Pessimo	□
STATO DI CONSERVAZIONE DELL'OPERA							
SCULTURE, ALTORILIEVI, BASSORILIEVI IN PIETRA							
SUPPORTO	Lesioni	□	Depositi superficiali	□	Croste	□	
	Distacchi	□	Alterazione cromatica	□	Degradazione differ.le	□	
	Disgregazione	□	Erosione	√	Esfoliazione	□	
	Incrostazione	□	Macchia	□	Mancanza	√	
	Patina	□	Pellicola	□	Pitting	□	
	Polverizzazione	□	Altro			□	

Appendix B: the Carthusian monastery of Trisulti in Collepardo

QUADRO D'INSIEME



PIANTA QUOTA +1,75 m

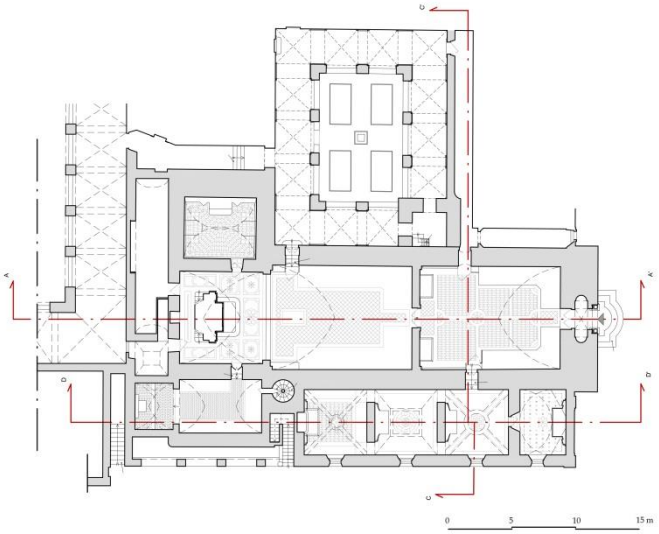


FOTO D'INQUADRAMENTO

Identificazione dell'edificio				Scheda n°	1	Data		18/03/2014	
Regione	Lazio			Complesso edilizio composto da			4	corpi di fabbrica isolati	
							2	corpi di fabbrica aggregati	
Provincia	Frosinone			Codice identificativo					
Comune	Collepardo			Dati Catastali		Foglio		Allegato	
				Particelle					
Frazione/Località	Trisulti			Posizione edificio		1 √ Isolato	2 ○ Interno	3 ○ D'estremità	4 ○ D'angolo
Indirizzo	via Trisulti			Coordinate geografiche (ED50 - UTM fuso 32 - 33)					
				E	13.39813				Fuso
Num. Civico	20	C.A.P.	03010	N	41.78007				
Denominazione edificio				Certosa di Trisulti - Chiesa					
Proprietario				Mibac/Diocesi					
Utilizzatore				Mibac/Diocesi					

Dati dimensionali ed età costruzione/ristrutturazione									
N° Piani totali interrati		Altezza media di piano [m]		Superficie media di piano [m^2]		Volume oggetto di verifica [m^3]		D	Anno di progettazione	1204
A	–	B	15,00	C	703,4	H	10551	E	Anno di ultimazione della costruzione	600-'700
F	○ Nessun intervento eseguito sulla struttura dopo la costruzione									
G				G1	○ Adeg.	G2	○ Miglior.	G3	√ Altro	

Materiale strutturale principale della struttura verticale

Strutture verticali \ Strutture orizzontali	Non identificato	Strutture in muratura						
		A tessitura irregolare e di cattiva qualità		A tessitura regolare e di buona qualità		Pilastri isolati	Mista	Rinforzata
		Senza catene o cordoli	Con catene o cordoli	Senza catene o cordoli	Con catene o cordoli			
	A	B	C	D	E	F	G	H
Non identificato	○	□	□	□	□	SI	□	□
Volte senza catene	□	□	□	√	□	○	G1	H1
Volte con catene	□	□	□	□	□		□	□
Travi con soletta deformabile	□	□	□	□	□	NO	G2	H2
Travi con soletta semirigida	□	□	□	□	□	○	□	□
Travi con soletta rigida	□	□	□	□	□		G3	H3

Regolarità	Non regolare	Regolare	Copertura		
	A	B			
Forma pianta ed elevazione	○	√	1	○	Spingente pesante
			2	○	Non spingente pesante
Disposizione tamponature	○	○	3	○	Spingente leggera
			4	√	Non spingente

Figure A.8. Results of thermography

ELEMENTI COSTITUTIVI								
MATERIALE	Arenaria	□	Calcare	√	Tufo	□	Calcarenite	□
	Mattoni cotti	□	Mattoni crudi	□	Vario di reimpiego	□	Altro	□
LAVORAZIONE	Assente (ciottoli)	□	Sbozzatura	√	A spigoli finiti	□	A conci squadrati	√
DIMENSIONE (diagonale elemento)	Piccole (< 15 cm)	□	Medie (15 - 25 cm)		√	Grandi (> 25 cm)		□
STATO DI CONSERVAZIONE E QUALITA'	Pessimo	□	Discreto		□	Buono		□
MALTA								
TIPO	Di calce aerea	□	Di calce idraulica	□	Cementizia	□	Altro	√
STATO DI CONSERVAZIONE E CONSISTENZA	Incoerente	□	Friabile		□	Tenace		□
FUNZIONE	Allettamento	√	Riempimento		□	Stilatura		√
POSA IN OPERA DEGLI ELEMENTI								
TESSITURA DEI PARAMENTI								
APPARECCHIATURA	Disordinata	□	Corsi irregolari		□	Corsi orizzontali		√
POSA DEGLI ELEMENTI	Casuale	√	A lisca di pesce	□	Orizzontale/Verticale	√	Orizzontale	□
RICORSI O LISTATURA	Assenti	√	In mattoni		□	Altro		□
ZEPPE O SCAGLIE	Assenti	□	In pietra		√	In cotto		□
SEZIONE TRASVERSALE								
TIPOLOGIA	Paramento unico	√	Due paramenti accostati		□	Due paramenti ammorsati		□
	A sacco (incoerente)	□	A sacco (coerente)		□	Paramento aggiunto		□
SPESSORI	Totale	□	Paramento esterno		□	Paramento interno		□
PRESENZA SIGNIFICATIVA DI VUOTI		□	**PRESENZA DI DIATONI**					□
INTONACO								
STATO ATTUALE	Muratura faccia a vista	√	Mancante	□	In parte mancante	□	Presente	√
TO DI CONSERVAZIONE E CONSISTEN	Degradato	√	Fessurato		□	Buono		□
COLLEGAMENTI TRA LE PARETI MURARIE								
ANGOLATE								
TIPOLOGIA	Ammorsamento scadente	□	Collegamenti irregolari		□	Alternanza regolare		√
ELEMENTI COSTITUTIVI	Analoghi alla muratura	□	Di dimensione maggiore		√	A conci squadrati		□
MARTELLI								
TIPOLOGIA	Assenza di collegamento	□	Ammorsamento scadente		□	Collegamenti efficaci		□
DIFFERENTE TIPOLOGIA DEI MURI DI SPINA		□	**FREQUENTE PRESENZA DI CATENE**					□
INTERVENTI DI CONSOLIDAMENTO								
ALLA MURATURA	Nessuno	√	Scuci-cuci in mattoni		□	Scuci-cuci in pietra		□
	Stilatura dei giunti	□	Iniezioni di malta		□	Intonaco armato		□
AI COLLEGAMENTI	Nessuno	√	Tamponatura di aperture	□	Collegamento travi	□	Catene	□
	Cuciture armate	□	Cordoli in muratura	□	Cordoli in c.a.	□	Orizzontamenti rigidi	□

Figure A.9. "Il quadro della fondazione", Fra Francesco David

Table A.9. Sheet "Il quadro della fondazione": Identification of the artwork

Identification of the artwork						
Object	Painting					
Subject	Il quadro della fondazione					
Author	Fra Francesco David					
Cultural Context						
Chronology	year 1702		century		era	
Position	Church	√	Museum room	□	Palace	□
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	□	Wall sx	□	Lunette dx	□
	Lunette sx	□	Vault	□	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	√

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	230				400			
Tipologia	Amovibile			√	Inamovibile			□
	Opera isolata			□	Serie			□
	Frammento			□	Altro			□
	Note							
Precedenti restauri	Interventi documentati			□	Interventi non documentati			□
	Note							
	Rifacimenti/Aggiunte							
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	□	Cavi eletti	□
	Note							

CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC
	Affreschi	□			Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	√		
	Arazzi	□			Arredi	□		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		

MATERIALI						
STRUTTURE DI SOSTEGNO	Fisse	√	Mobili	□	Sospese	□
	Vetrina	□	Cavalletto	□	Mensola	□
	Bacheca	□	Piedistallo	□	Soffitto	□
	Parete	√	Pavimento	□	Pannello	□
	Scaffalatura	□	Rastrelliera	□	Altro	□
	Note					
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	□	Telaio	√	Chiodi	√
	Corde o fili metallici	√	Base murale	□	Parchettature	□
	Altro					□
SUPPORTO	Tela	√	Legno	□	Metallo	□
	Vetro	□	Carta	□	Pietra	□
	Cuoio	□	Pergamena	□	Intonaco - Muratura	□

Misure del supporto [cm]	Altezza [H]	Profondità [P]	Larghezza [L]	Diametro [D]

STRUTTURE AUSILIARIE SUPPORTO						
	Cornice	Solidale al supporto o parte integrante di esso		√	SI □	NO □
		Vincolata rigidamente		□	SI □	NO □
		Ligena	□	Metallica		□
		Gesso	√	Listello		□
		Modanata	□	Dorata		□
		Dipinta	□	Intagliata		□
		Intarsiata	□	Altro		□
	Telaio	Ligneo	□	Rigido		□
		Metallico	□	Scomponibile		□
		Mobile	□	Altro		√
STRATI PREPARATORI	Gesso	□	Intonaco	□	Colla	□
PELLICOLA PITTORICA	Dipinti a olio	√	Dipinti a tempera	□	Acquerelli	□

Coefficiente d'attrito - Superficie materiali					
Alluminio su formica	0,12	Teflon su mosaico	0,10	Plexiglass su vetro	0,20
Marmo su formica	0,18	Alluminio su legno	0,37	Plexiglass su teflon	0,15
Teflon su formica	0,13	Alluminio su alluminio	0,24	Teflon su vetro	0,13
Alluminio su mosaico	0,20	Alluminio su teflon	0,23	Terracotta su plexiglass	0,30
Marmo su mosaico	0,13	Plexiglass su plexiglass	0,35	Terracotta su vetro	0,30

Classificazione dell'opera								
Classificazione dell'opera in base alla tipologia								
T1	□	Piccoli oggetti a base piana						
T2	□	Piccoli oggetti privi di base piana						
T3	□	Statue, sculture e grandi vasi						
T4	√	Quadri e dipinti						
T5	□	Lampadari ed oggetti sospesi						
T6	□	Altro						

Classificazione dell'opera in base alla tipologia di sostegno								
	A				**B**	**C**		**D**
	Oggetti poggiati su una superficie piana				Oggetti fissati su un piedistallo	Oggetti appesi o sospesi		Altro
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	mensole o all'interno di		appesi ad una parete	sospesi al soffitto	
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	-	*	-	-	-
T4	-	-	-	-	-	*	-	√
T5	-	-	-	-	-	-	*	-
T6	*	*	*	*	*	*	*	*

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte				**Sigla**
Categoria	**Modalità di risposta**		**Meccanismi di danno**	
A	moto attaccato	□	sollecitazioni eccessive	□	R1
	scivolamento	□	spostamenti eccessivi	□	R2
	oscillazioni	□	urti ripetuti	□	R3
	oscillazioni	□	ribaltamento	□	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	□	sollecitazioni eccessive	□	R1
	moto attaccato	√	spostamenti eccessivi	√	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	√	Discreto	□	Scadente	□	Pessimo	□

STATO DI CONSERVAZIONE DELL'OPERA						
DIPINTI SU TELA						
TELAIO LIGNEO	Aggressione da insetti	□	Sali di rame	□	Alterazione cromatica	□
	Marcescenza	□	Macchie di ruggine	□	Carie	□
	Note: telaio non visibile					√
SUPPORTO	Lacerazioni	□	Strappi	□	Rilassamento	□
	Aggressione da insetti	□	Bruciature	□	Macchie di umidità	□
PELLICOLA PITTORICA	Distacco	□	Decoesione	□	Patina biologica	□
	Polverizzazione	□	Macchie di umidità	□	Tracce di bruciature	□
	Caduta di colore	√	Efflorescenza salina	□	Lacune	□
	Altro					□

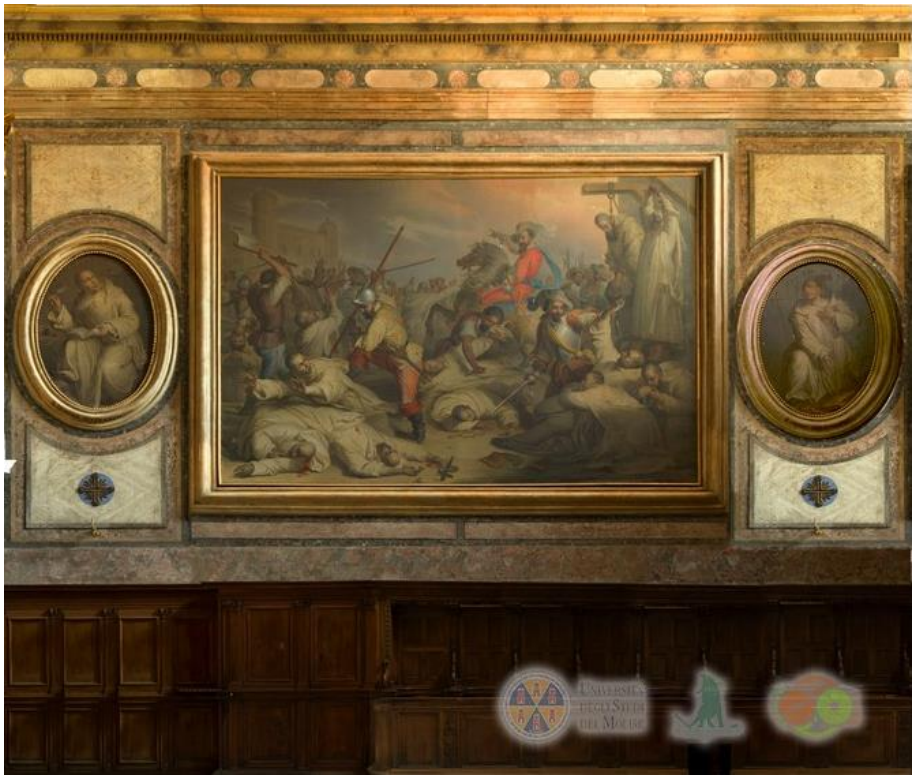


Figure A.10. Right wall

Table A.10. Sheet "Beato Oddone": Identification of the artwork

Identification of the artwork						
Object	Oval-shaped Painting					
Subject	Il beato Oddone					
Author	Filippo Balbi					
Cultural Context						
Chronology	year 1863 circa		century		era	
Position	Church	√	Museum room	□	Palace	□
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	√	Wall sx	□	Lunette dx	□
	Lunette sx	□	Vault	□	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	□

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	200				140			
Tipologia	Amovibile			√	Inamovibile			□
	Opera isolata			□	Serie			√
	Frammento			□	Altro			□
	Note							
Precedenti restauri	Interventi documentati			□	Interventi non documentati			□
	Note							
	Rifacimenti/Aggiunte							
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	□	Cavi elettric	□
	Note							

CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC.
	Affreschi	□			Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	√		
	Arazzi	□			Arredi	□		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		

MATERIALI						
STRUTTURE DI SOSTEGNO	Fisse	√	Mobili	□	Sospese	□
	Vetrina	□	Cavalletto	□	Mensola	□
	Bacheca	□	Piedistallo	□	Soffitto	□
	Parete	√	Pavimento	□	Pannello	□
	Scaffalatura	□	Rastrelliera	□	Altro	□
	Note					
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	□	Telaio	√	Chiodi	√
	Corde o fili metallici	√	Base murale	□	Parchettature	□
	Altro					□
SUPPORTO	Tela	√	Legno	□	Metallo	□
	Vetro	□	Carta	□	Pietra	□
	Cuoio	□	Pergamena	□	Intonaco/Muratura	□

Misure del supporto [cm]	**Altezza [H]**	**Profondità [P]**	**Larghezza [L]**	**Diametro [D]**

STRUTTURE AUSILIARIE SUPPORTO						
		Solidale al supporto o parte integrante di esso		√	SI □	NO □
		Vincolata rigidamente		□	SI □	NO □
	Cornice	Ligena	□	Metallica	□	
		Gesso	√	Listello	□	
		Modanata	□	Dorata	√	
		Dipinta	□	Intagliata	□	
		Intarsiata	□	Altro	□	
	Telaio	Ligneo	√	Rigido	□	
		Metallico	□	Scomponibile	□	
		Mobile	□	Altro	□	

STRATI PREPARATORI	Gesso	□	Intonaco	□	Colla	□
PELLICOLA PITTORICA	Dipinti a olio	√	Dipinti a tempera	□	Acquerelli	□

Coefficiente d'attrito - Superficie materiali					
Alluminio su formica	0,12	Teflon su mosaico	0,10	Plexiglass su vetro	0,20
Marmo su formica	0,18	Alluminio su legno	0,37	Plexiglass su teflon	0,15
Teflon su formica	0,13	Alluminio su alluminio	0,24	Teflon su vetro	0,13
Alluminio su mosaico	0,20	Alluminio su teflon	0,23	Terracotta su plexiglass	0,30
Marmo su mosaico	0,13	Plexiglass su plexiglass	0,35	Terracotta su vetro	0,30

Classificazione dell'opera		
Classificazione dell'opera in base alla tipologia		
T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	□	Statue, sculture e grandi vasi
T4	√	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	□	Altro

Classificazione dell'opera in base alla tipologia di sostegno								
	A				**B**	**C**		**D**
	Oggetti poggiati su una superficie piana				Oggetti fissati su un piedistallo	Oggetti appesi o sospesi		Altro
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	su mensole o all'interno di bacheche		appesi ad una parete	sospesi al soffitto	
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	-	*	-	-	-
T4	-	-	-	-	-	*	-	√
T5	-	-	-	-	-	-	*	-
T6	*	*	*	*	*	*	*	*

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte					
Categoria	**Modalità di risposta**		**Meccanismi di danno**		**Sigla**
A	moto attaccato	□	sollecitazioni eccessive	□	R1
	scivolamento	□	spostamenti eccessivi	□	R2
	oscillazioni	□	urti ripetuti	□	R3
	oscillazioni	□	ribaltamento	□	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	□	sollecitazioni eccessive	□	R1
	moto attaccato	√	spostamenti eccessivi	√	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	□	Discreto	√	Scadente	□	Pessimo	□
STATO DI CONSERVAZIONE DELL'OPERA							
DIPINTI SU TELA							
TELAIO LIGNEO		Aggressione da insetti	□	Sali di rame	□	Alterazione cromatica	□
		Marcescenza	□	Macchie di ruggine	□	Carie	□
		Note: telaio non visibile					√
SUPPORTO		Lacerazioni	□	Strappi	□	Rilassamento	□
		Aggressione da insetti	□	Bruciature	□	Macchie di umidità	□
PELLICOLA PITTORICA		Distacco	□	Decoesione	□	Patina biologica	□
		Polverizzazione	□	Macchie	√	Tracce di bruciature	□
		Caduta di colore	√	Efflorescenza salina	□	Lacune	□
		Altro					□

Table A.11. Sheet "Beato Dioniso": Identification of the artwork

Identification of the artwork						
Object	Oval-shaped Painting					
Subject	Il beato Dioniso					
Author	Filippo Balbi					
Cultural Context						
Chronology	year 1863 circa		century		era	
Position	Church	√	Museum room	□	Palace	□
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	√	Wall sx	□	Lunette dx	□
	Lunette sx	□	Vault	□	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	□

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	200				140			
Tipologia	Amovibile			√	Inamovibile			□
	Opera isolata			□	Serie			√
	Frammento			□	Altro			□
	Note							
Precedenti restauri	Interventi documentati			□	Interventi non documentati			□
	Note							
	Rifacimenti/Aggiunte							
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	□	Cavi elettric	□
	Note							

CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC.
	Affreschi	□			Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	√		
	Arazzi	□			Arredi	□		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		

MATERIALI						
STRUTTURE DI SOSTEGNO	Fisse	√	Mobili	□	Sospese	□
	Vetrina	□	Cavalletto	□	Mensola	□
	Bacheca	□	Piedistallo	□	Soffitto	□
	Parete	√	Pavimento	□	Pannello	□
	Scaffalatura	□	Rastrelliera	□	Altro	□
	Note					
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	□	Telaio	√	Chiodi	√
	Corde o fili metallici	√	Base murale	□	Parchettature	□
	Altro					□
SUPPORTO	Tela	√	Legno	□	Metallo	□
	Vetro	□	Carta	□	Pietra	□
	Cuoio	□	Pergamena	□	Intonaco/Muratura	□

Misure del supporto [cm]	Altezza [H]	Profondità [P]	Larghezza [L]	Diametro [D]

STRUTTURE AUSILIARIE SUPPORTO							
		Solidale al supporto o parte integrante di esso			√	SI □	NO □
		Vincolata rigidamente			□	SI □	NO □
	Cornice	Ligena	□	Metallica		□	
		Gesso	√	Listello		□	
		Modanata	□	Dorata		√	
		Dipinta	□	Intagliata		□	
		Intarsiata	□	Altro		□	
	Telaio	Ligneo	√	Rigido		□	
		Metallico	□	Scomponibile		□	
		Mobile	□	Altro		□	

STRATI PREPARATORI	Gesso	□	Intonaco	□	Colla	□
PELLICOLA PITTORICA	Dipinti a olio	√	Dipinti a tempera	□	Acquerelli	□

Coefficiente d'attrito - Superficie materiali					
Alluminio su formica	0,12	Teflon su mosaico	0,10	Plexiglass su vetro	0,20
Marmo su formica	0,18	Alluminio su legno	0,37	Plexiglass su teflon	0,15
Teflon su formica	0,13	Alluminio su alluminio	0,24	Teflon su vetro	0,13
Alluminio su mosaico	0,20	Alluminio su teflon	0,23	Terracotta su plexiglass	0,30
Marmo su mosaico	0,13	Plexiglass su plexiglass	0,35	Terracotta su vetro	0,30

Classificazione dell'opera		
Classificazione dell'opera in base alla tipologia		
T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	□	Statue, sculture e grandi vasi
T4	√	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	□	Altro

Classificazione dell'opera in base alla tipologia di sostegno								
	A				**B**	**C**		**D**
	Oggetti poggiati su una superficie piana				Oggetti fissati su un piedistallo	Oggetti appesi o sospesi		Altro
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	su mensole o all'interno di bacheche		appesi ad una parete	sospesi al soffitto	
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	-	*	-	-	-
T4	-	-	-	-	-	*	-	√
T5	-	-	-	-	-	-	*	-
T6	*	*	*	*	*	*	*	*

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte					
Categoria	**Modalità di risposta**		**Meccanismi di danno**		**Sigla**
A	moto attaccato	□	sollecitazioni eccessive	□	R1
	scivolamento	□	spostamenti eccessivi	□	R2
	oscillazioni	□	urti ripetuti	□	R3
	oscillazioni	□	ribaltamento	□	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	□	sollecitazioni eccessive	□	R1
	moto attaccato	√	spostamenti eccessivi	√	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	√	Discreto	□	Scadente	□	Pessimo	□
STATO DI CONSERVAZIONE DELL'OPERA							
DIPINTI SU TELA							
TELAIO LIGNEO		Aggressione da insetti	□	Sali di rame	□	Alterazione cromatica	□
		Marcescenza	□	Macchie di ruggine	□	Carie	□
		Note: telaio non visibile					√
SUPPORTO		Lacerazioni	□	Strappi	□	Rilassamento	□
		Aggressione da insetti	□	Bruciature	□	Macchie di umidità	□
PELLICOLA PITTORICA		Distacco	□	Decoesione	□	Patina biologica	□
		Polverizzazione	□	Macchie	□	Tracce di bruciature	□
		Caduta di colore	√	Efflorescenza salina	□	Lacune	□
		Altro					□

Table A.12. Sheet "Martirio dei Certosini": Identification of the artwork

Identification of the artwork						
Object	Painting					
Subject	Martirio dei Certosini avvenuto a Londra nel 1535					
Author	Filippo Balbi					
Cultural Context						
Chronology	year 1861		century		era	
Position	Church	√	Museum room	□	Palace	□
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	√	Wall sx	□	Lunette dx	□
	Lunette sx	□	Vault	□	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	□

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	370				590			
Tipologia	Amovibile			√	Inamovibile			□
	Opera isolata			□	Serie			□
	Frammento			□	Altro			□
	Note							
Precedenti restauri	Interventi documentati			□	Interventi non documentati			□
	Note							
	Rifacimenti/Aggiunte							
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	□	Cavi elettric	□
	Note							

CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC.
	Affreschi	□			Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	√		
	Arazzi	□			Arredi	□		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		

MATERIALI								
STRUTTURE DI SOSTEGNO	Fisse	√	Mobili	□	Sospese	□		
	Vetrina	□	Cavalletto	□	Mensola	□		
	Bacheca	□	Piedistallo	□	Soffitto	□		
	Parete	√	Pavimento	□	Pannello	□		
	Scaffalatura	□	Rastrelliera	□	Altro	□		
	Note							
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	□	Telaio	√	Chiodi	√		
	Corde o fili metallici	√	Base murale	□	Parchettature	□		
	Altro						□	
SUPPORTO	Tela	√	Legno	□	Metallo	□		
	Vetro	□	Carta	□	Pietra	□		
	Cuoio	□	Pergamena	□	Intonaco/Muratura	□		
Misure del supporto [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
STRUTTURE AUSILIARIE SUPPORTO		Solidale al supporto o parte integrante di esso				√	SI □	NO □
		Vincolata rigidamente				□	SI □	NO □
	Cornice	Ligena	□	Metallica			□	
		Gesso	√	Listello			□	
		Modanata	□	Dorata			√	
		Dipinta	□	Intagliata			□	
		Intarsiata	□	Altro			□	
	Telaio	Ligneo	√	Rigido			□	
		Metallico	□	Scomponibile			□	
		Mobile	□	Altro			□	
STRATI PREPARATORI	Gesso	□	Intonaco	□	Colla	□		
PELLICOLA PITTORICA	Dipinti a olio	√	Dipinti a tempera	□	Acquerelli	□		

Coefficiente d'attrito - Superficie materiali					
Alluminio su formica	0,12	Teflon su mosaico	0,10	Plexiglass su vetro	0,20
Marmo su formica	0,18	Alluminio su legno	0,37	Plexiglass su teflon	0,15
Teflon su formica	0,13	Alluminio su alluminio	0,24	Teflon su vetro	0,13
Alluminio su mosaico	0,20	Alluminio su teflon	0,23	Terracotta su plexiglass	0,30
Marmo su mosaico	0,13	Plexiglass su plexiglass	0,35	Terracotta su vetro	0,30

Classificazione dell'opera

Classificazione dell'opera in base alla tipologia

T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	□	Statue, sculture e grandi vasi
T4	√	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	□	Altro

Classificazione dell'opera in base alla tipologia di sostegno

	A				B	C		D
	Oggetti poggiati su una superficie piana				Oggetti fissati su un piedistallo	Oggetti appesi o sospesi		Altro
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	su mensole o all'interno di bacheche		appesi ad una parete	sospesi al soffitto	
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	-	*	-	-	-
T4	-	-	-	-	-	*	-	√
T5	-	-	-	-	-	-	*	-
T6	*	*	*	*	*	*	*	*

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte

Categoria	Modalità di risposta		Meccanismi di danno		Sigla
A	moto attaccato	□	sollecitazioni eccessive	□	R1
	scivolamento	□	spostamenti eccessivi	□	R2
	oscillazioni	□	urti ripetuti	□	R3
	oscillazioni	□	ribaltamento	□	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	□	sollecitazioni eccessive	□	R1
	moto attaccato	√	spostamenti eccessivi	√	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	√	Discreto	□	Scadente	□	Pessimo	□
STATO DI CONSERVAZIONE DELL'OPERA							
DIPINTI SU TELA							
TELAIO LIGNEO		Aggressione da insetti	□	Sali di rame	□	Alterazione cromatica	□
		Marcescenza	□	Macchie di ruggine	□	Carie	□
		Note: telaio non visibile					√
SUPPORTO		Lacerazioni	□	Strappi	□	Rilassamento	□
		Aggressione da insetti	□	Bruciature	□	Macchie di umidità	□
PELLICOLA PITTORICA		Distacco	□	Decoesione	□	Patina biologica	□
		Polverizzazione	□	Macchie di umidità	□	Tracce di bruciature	□
		Caduta di colore	√	Efflorescenza salina	□	Lacune	□
		Altro					□

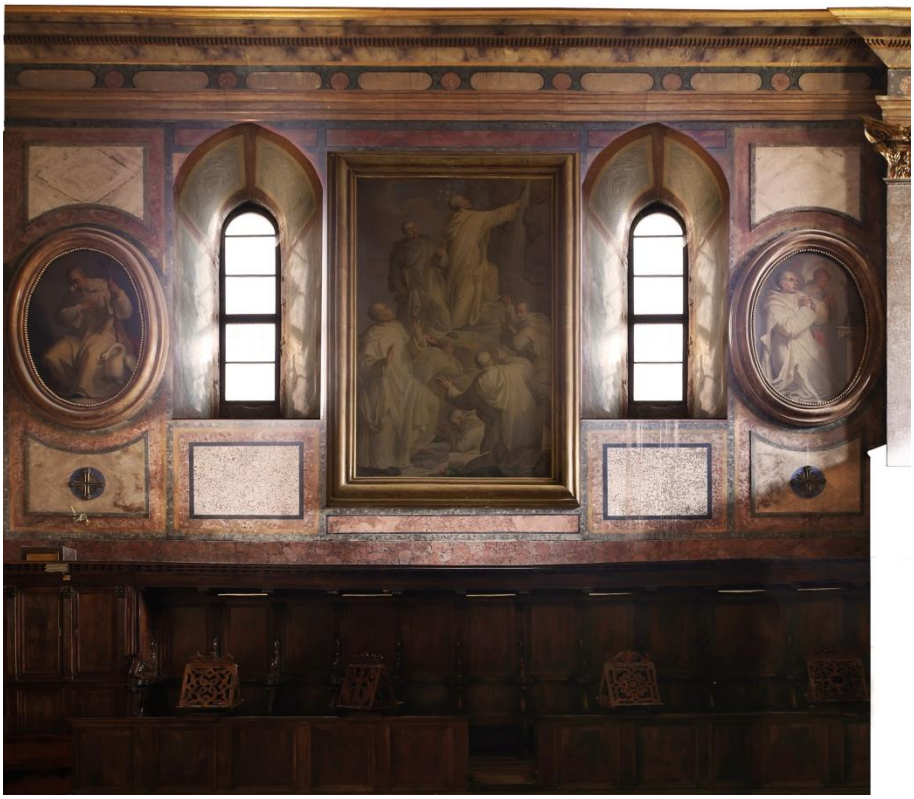


Figure A.11. Right wall

Table A.13. Sheet "Sant'Ugo": Identification of the artwork

Identification of the artwork						
Object	Oval-shaped Painting					
Subject	S. Ugo vescovo di Lincoln					
Author	Filippo Balbi					
Cultural Context						
Chronology	year 1863 circa		century		era	
Position	Church	√	Museum room	□	Palace	□
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	√	Wall sx	□	Lunette dx	□
	Lunette sx	□	Vault	□	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	□

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	200				140			
Tipologia	Amovibile			√	Inamovibile			□
	Opera isolata			□	Serie			√
	Frammento			□	Altro			□
	Note							
Precedenti restauri	Interventi documentati			□	Interventi non documentati			□
	Note							
	Rifacimenti/Aggiunte							
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	□	Cavi elettric	□
	Note							

CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC.
	Affreschi	□			Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	√		
	Arazzi	□			Arredi	□		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		

MATERIALI								
STRUTTURE DI SOSTEGNO	Fisse	√	Mobili	□	Sospese	□		
	Vetrina	□	Cavalletto	□	Mensola	□		
	Bacheca	□	Piedistallo	□	Soffitto	□		
	Parete	√	Pavimento	□	Pannello	□		
	Scaffalatura	□	Rastrelliera	□	Altro	□		
	Note							
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	□	Telaio	√	Chiodi	√		
	Corde o fili metallici	√	Base murale	□	Parchettature	□		
	Altro						□	
SUPPORTO	Tela	√	Legno	□	Metallo	□		
	Vetro	□	Carta	□	Pietra	□		
	Cuoio	□	Pergamena	□	Intonaco/Muratura	□		
Misure del supporto [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
STRUTTURE AUSILIARIE SUPPORTO		Solidale al supporto o parte integrante di esso				√	SI □	NO □
		Vincolata rigidamente				□	SI □	NO □
	Cornice	Ligena	□	Metallica			□	
		Gesso	√	Listello			□	
		Modanata	□	Dorata			√	
		Dipinta	□	Intagliata			□	
		Intarsiata	□	Altro			□	
	Telaio	Ligneo	√	Rigido			□	
		Metallico	□	Scomponibile			□	
		Mobile	□	Altro			□	
STRATI PREPARATORI	Gesso	□	Intonaco	□	Colla	□		
PELLICOLA PITTORICA	Dipinti a olio	√	Dipinti a tempera	□	Acquerelli	□		

Coefficiente d'attrito - Superficie materiali					
Alluminio su formica	0,12	Teflon su mosaico	0,10	Plexiglass su vetro	0,20
Marmo su formica	0,18	Alluminio su legno	0,37	Plexiglass su teflon	0,15
Teflon su formica	0,13	Alluminio su alluminio	0,24	Teflon su vetro	0,13
Alluminio su mosaico	0,20	Alluminio su teflon	0,23	Terracotta su plexiglass	0,30
Marmo su mosaico	0,13	Plexiglass su plexiglass	0,35	Terracotta su vetro	0,30

Classificazione dell'opera		
Classificazione dell'opera in base alla tipologia		
T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	□	Statue, sculture e grandi vasi
T4	√	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	□	Altro

Classificazione dell'opera in base alla tipologia di sostegno								
	A				**B**	**C**		**D**
	Oggetti poggiati su una superficie piana				Oggetti fissati su un piedistallo	Oggetti appesi o sospesi		Altro
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	su mensole o all'interno di bacheche		appesi ad una parete	sospesi al soffitto	
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	-	*	-	-	-
T4	-	-	-	-	-	*	-	√
T5	-	-	-	-	-	-	*	-
T6	*	*	*	*	*	*	*	*

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte					
Categoria	**Modalità di risposta**		**Meccanismi di danno**		**Sigla**
A	moto attaccato	□	sollecitazioni eccessive	□	R1
	scivolamento	□	spostamenti eccessivi	□	R2
	oscillazioni	□	urti ripetuti	□	R3
	oscillazioni	□	ribaltamento	□	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	□	sollecitazioni eccessive	□	R1
	moto attaccato	√	spostamenti eccessivi	√	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	□	Discreto	√	Scadente	□	Pessimo	□
STATO DI CONSERVAZIONE DELL'OPERA							
DIPINTI SU TELA							
TELAIO LIGNEO		Aggressione da insetti	□	Sali di rame	□	Alterazione cromatica	□
		Marcescenza	□	Macchie di ruggine	□	Carie	□
		Note: telaio non visibile					√
SUPPORTO		Lacerazioni	□	Strappi	□	Rilassamento	□
		Aggressione da insetti	□	Bruciature	□	Macchie di umidità	□
PELLICOLA PITTORICA		Distacco	□	Decoesione	□	Patina biologica	□
		Polverizzazione	□	Macchie	√	Tracce di bruciature	□
		Caduta di colore	√	Efflorescenza salina	□	Lacune	□
		Altro					□

Table A.14. Sheet "Santo Stefano": Identification of the artwork

Identification of the artwork						
Object	Oval-shaped Painting					
Subject	Santo Stefano vescovo di Diè					
Author	Filippo Balbi					
Cultural Context						
Chronology	year 1863 circa		century		era	
Position	Church	√	Museum room	□	Palace	□
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	√	Wall sx	□	Lunette dx	□
	Lunette sx	□	Vault	□	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	□

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	200				140			
Tipologia	Amovibile			√	Inamovibile			□
	Opera isolata			□	Serie			√
	Frammento			□	Altro			□
	Note							
Precedenti restauri	Interventi documentati			□	Interventi non documentati			□
	Note							
	Rifacimenti/Aggiunte							
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	□	Cavi elettric	□
	Note							

CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC.
	Affreschi	□			Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	√		
	Arazzi	□			Arredi	□		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		

MATERIALI								
STRUTTURE DI SOSTEGNO	Fisse	√	Mobili	□	Sospese	□		
	Vetrina	□	Cavalletto	□	Mensola	□		
	Bacheca	□	Piedistallo	□	Soffitto	□		
	Parete	√	Pavimento	□	Pannello	□		
	Scaffalatura	□	Rastrelliera	□	Altro	□		
	Note							
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	□	Telaio	√	Chiodi	√		
	Corde o fili metallici	√	Base murale	□	Parchettature	□		
	Altro						□	
SUPPORTO	Tela	√	Legno	□	Metallo	□		
	Vetro	□	Carta	□	Pietra	□		
	Cuoio	□	Pergamena	□	Intonaco/Muratura	□		
Misure del supporto [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
STRUTTURE AUSILIARIE SUPPORTO		Solidale al supporto o parte integrante di esso				√	SI □	NO □
		Vincolata rigidamente				□	SI □	NO □
	Cornice	Ligena	□	Metallica			□	
		Gesso	√	Listello			□	
		Modanata	□	Dorata			√	
		Dipinta	□	Intagliata			□	
		Intarsiata	□	Altro			□	
	Telaio	Ligneo	√	Rigido			□	
		Metallico	□	Scomponibile			□	
		Mobile	□	Altro			□	
STRATI PREPARATORI	Gesso	□	Intonaco	□	Colla	□		
PELLICOLA PITTORICA	Dipinti a olio	√	Dipinti a tempera	□	Acquerelli	□		

Coefficiente d'attrito - Superficie materiali					
Alluminio su formica	0,12	Teflon su mosaico	0,10	Plexiglass su vetro	0,20
Marmo su formica	0,18	Alluminio su legno	0,37	Plexiglass su teflon	0,15
Teflon su formica	0,13	Alluminio su alluminio	0,24	Teflon su vetro	0,13
Alluminio su mosaico	0,20	Alluminio su teflon	0,23	Terracotta su plexiglass	0,30
Marmo su mosaico	0,13	Plexiglass su plexiglass	0,35	Terracotta su vetro	0,30

Classificazione dell'opera

Classificazione dell'opera in base alla tipologia

T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	□	Statue, sculture e grandi vasi
T4	√	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	□	Altro

Classificazione dell'opera in base alla tipologia di sostegno

	A				B	C		D
	Oggetti poggiati su una superficie piana				Oggetti fissati su un piedistallo	Oggetti appesi o sospesi		Altro
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	su mensole o all'interno di bacheche		appesi ad una parete	sospesi al soffitto	
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	-	*	-	-	-
T4	-	-	-	-	-	*	-	√
T5	-	-	-	-	-	-	*	-
T6	*	*	*	*	*	*	*	*

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte

Categoria	Modalità di risposta		Meccanismi di danno		Sigla
A	moto attaccato	□	sollecitazioni eccessive	□	R1
	scivolamento	□	spostamenti eccessivi	□	R2
	oscillazioni	□	urti ripetuti	□	R3
	oscillazioni	□	ribaltamento	□	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	□	sollecitazioni eccessive	□	R1
	moto attaccato	√	spostamenti eccessivi	√	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	□	Discreto	√	Scadente	□	Pessimo	□
STATO DI CONSERVAZIONE DELL'OPERA							
DIPINTI SU TELA							
TELAIO LIGNEO		Aggressione da insetti	□	Sali di rame	□	Alterazione cromatica	□
		Marcescenza	□	Macchie di ruggine	□	Carie	□
		Note: telaio non visibile					√
SUPPORTO		Lacerazioni	□	Strappi	□	Rilassamento	□
		Aggressione da insetti	□	Bruciature	□	Macchie di umidità	□
PELLICOLA PITTORICA		Distacco	□	Decoesione	□	Patina biologica	□
		Polverizzazione	□	Macchie	√	Tracce di bruciature	□
		Caduta di colore	√	Efflorescenza salina	□	Lacune	□
		Altro					□

Table A.15. Sheet "San Bruno fa scaturire l'acqua": Identification of the artwork

Identification of the artwork						
Object	Painting					
Subject	San Bruno fa scaturire l'acqua					
Author	Filippo Balbi					
Cultural Context						
Chronology	year 1859		century		era	
Position	Church	√	Museum room	□	Palace	□
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	√	Wall sx	□	Lunette dx	□
	Lunette sx	□	Vault	□	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	□

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	390				250			
Tipologia	Amovibile			√	Inamovibile			□
	Opera isolata			□	Serie			□
	Frammento			□	Altro			□
	Note							
Precedenti restauri	Interventi documentati			□	Interventi non documentati			□
	Note							
	Rifacimenti/Aggiunte							
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	□	Cavi elettric	□
	Note							

CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC.
	Affreschi	□			Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	√		
	Arazzi	□			Arredi	□		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		

MATERIALI								
STRUTTURE DI SOSTEGNO	Fisse	√	Mobili	□	Sospese	□		
	Vetrina	□	Cavalletto	□	Mensola	□		
	Bacheca	□	Piedistallo	□	Soffitto	□		
	Parete	√	Pavimento	□	Pannello	□		
	Scaffalatura	□	Rastrelliera	□	Altro	□		
	Note							
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	□	Telaio	√	Chiodi	√		
	Corde o fili metallici	√	Base murale	□	Parchettature	□		
	Altro						□	
SUPPORTO	Tela	√	Legno	□	Metallo	□		
	Vetro	□	Carta	□	Pietra	□		
	Cuoio	□	Pergamena	□	Intonaco/Muratura	□		

Misure del supporto [cm]	**Altezza [H]**	**Profondità [P]**	**Larghezza [L]**	**Diametro [D]**

STRUTTURE AUSILIARIE SUPPORTO							
		Solidale al supporto o parte integrante di esso		√	SI □	NO □	
		Vincolata rigidamente		□	SI □	NO □	
	Cornice	Ligena	□	Metallica	□		
		Gesso	√	Listello	□		
		Modanata	□	Dorata	√		
		Dipinta	□	Intagliata	□		
		Intarsiata	□	Altro	□		
	Telaio	Ligneo	√	Rigido	□		
		Metallico	□	Scomponibile	□		
		Mobile	□	Altro	□		

STRATI PREPARATORI	Gesso	□	Intonaco	□	Colla	□	
PELLICOLA PITTORICA	Dipinti a olio	√	Dipinti a tempera	□	Acquerelli	□	

Coefficiente d'attrito - Superficie materiali					
Alluminio su formica	0,12	Teflon su mosaico	0,10	Plexiglass su vetro	0,20
Marmo su formica	0,18	Alluminio su legno	0,37	Plexiglass su teflon	0,15
Teflon su formica	0,13	Alluminio su alluminio	0,24	Teflon su vetro	0,13
Alluminio su mosaico	0,20	Alluminio su teflon	0,23	Terracotta su plexiglass	0,30
Marmo su mosaico	0,13	Plexiglass su plexiglass	0,35	Terracotta su vetro	0,30

Classificazione dell'opera		
Classificazione dell'opera in base alla tipologia		
T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	□	Statue, sculture e grandi vasi
T4	√	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	□	Altro

Classificazione dell'opera in base alla tipologia di sostegno								
	A				**B**	**C**		**D**
	Oggetti poggiati su una superficie piana				Oggetti fissati su un piedistallo	Oggetti appesi o sospesi		Altro
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	su mensole o all'interno di bacheche		appesi ad una parete	sospesi al soffitto	
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	-	*	-	-	-
T4	-	-	-	-	-	*	-	√
T5	-	-	-	-	-	-	*	-
T6	*	*	*	*	*	*	*	*

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte					
Categoria	**Modalità di risposta**		**Meccanismi di danno**		**Sigla**
A	moto attaccato	□	sollecitazioni eccessive	□	R1
	scivolamento	□	spostamenti eccessivi	□	R2
	oscillazioni	□	urti ripetuti	□	R3
	oscillazioni	□	ribaltamento	□	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	□	sollecitazioni eccessive	□	R1
	moto attaccato	√	spostamenti eccessivi	√	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	√	Discreto	□	Scadente	□	Pessimo	□
STATO DI CONSERVAZIONE DELL'OPERA							
DIPINTI SU TELA							
TELAIO LIGNEO		Aggressione da insetti	□	Sali di rame	□	Alterazione cromatica	□
		Marcescenza	□	Macchie di ruggine	□	Carie	□
		Note: telaio non visibile					√
SUPPORTO		Lacerazioni	□	Strappi	□	Rilassamento	□
		Aggressione da insetti	□	Bruciature	□	Macchie di umidità	□
PELLICOLA PITTORICA		Distacco	□	Decoesione	□	Patina biologica	□
		Polverizzazione	□	Macchie di umidità	□	Tracce di bruciature	□
		Caduta di colore	√	Efflorescenza salina	□	Lacune	□
		Altro					□

Figure A.12. Right wall; *San Bruno in ginocchio ai piedi del papa Urbano II*

Table A.16. Sheet "San Bruno in ginocchio ai piedi del papa Urbano II": Identification of the artwork

Identification of the artwork						
Object	Painting					
Subject	San Bruno in ginocchio ai piedi del papa Urbano II					
Author	Giuseppe Battelli					
Cultural Context						
Chronology	year		century XIX		era	
Position	Church	√	Museum room	□	Palace	□
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	√	Wall sx	□	Lunette dx	□
	Lunette sx	□	Vault	□	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	□

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	246				440			
Tipologia	Amovibile			√	Inamovibile			□
	Opera isolata			□	Serie			□
	Frammento			□	Altro			□
	Note							
Precedenti restauri	Interventi documentati			□	Interventi non documentati			√
	Note							
	Rifacimenti/Aggiunte							
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	□	Cavi elettrici	□
	Note							

CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC.
	Affreschi	□			Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	√		
	Arazzi	□			Arredi	□		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		

MATERIALI								
STRUTTURE DI SOSTEGNO	Fisse	√	Mobili		□	Sospese		□
	Vetrina	□	Cavalletto		□	Mensola		□
	Bacheca	□	Piedistallo		□	Soffitto		□
	Parete	√	Pavimento		□	Pannello		□
	Scaffalatura	□	Rastrelliera		□	Altro		□
	Note							
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	□	Telaio		√	Chiodi		√
	Corde o fili metallici	√	Base murale		□	Parchettature		□
	Altro							□
SUPPORTO	Tela	√	Legno		□	Metallo		□
	Vetro	□	Carta		□	Pietra		□
	Cuoio	□	Pergamena		□	Intonaco/Muratura		□

Misure del supporto [cm]	Altezza [H]		Profondità [P]		Larghezza [L]		Diametro [D]	
STRUTTURE AUSILIARIE SUPPORTO	**Cornice**	Solidale al supporto o parte integrante di esso				√	SI □	NO □
		Vincolata rigidamente				□	SI □	NO □
		Ligena	□	Metallica				□
		Gesso	√	Listello				□
		Modanata	□	Dorata				√
		Dipinta	□	Intagliata				□
		Intarsiata	□	Altro				□
	Telaio	Ligneo	√	Rigido				□
		Metallico	□	Scomponibile				□
		Mobile	□	Altro				□
STRATI PREPARATORI	Gesso	□	Intonaco		□	Colla		□
PELLICOLA PITTORICA	Dipinti a olio	√	Dipinti a tempera		□	Acquerelli		□

Coefficiente d'attrito - Superficie materiali					
Alluminio su formica	0,12	Teflon su mosaico	0,10	Plexiglass su vetro	0,20
Marmo su formica	0,18	Alluminio su legno	0,37	Plexiglass su teflon	0,15
Teflon su formica	0,13	Alluminio su alluminio	0,24	Teflon su vetro	0,13
Alluminio su mosaico	0,20	Alluminio su teflon	0,23	Terracotta su plexiglass	0,30
Marmo su mosaico	0,13	Plexiglass su plexiglass	0,35	Terracotta su vetro	0,30

Classificazione dell'opera		
Classificazione dell'opera in base alla tipologia		
T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	□	Statue, sculture e grandi vasi
T4	√	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	□	Altro

Classificazione dell'opera in base alla tipologia del supporto

	A				B	C		D
	Oggetti poggiati su una superficie piana					Oggetti appesi o sospesi		
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	su mensole o all'interno di bacheche	Oggetti fissati su un piedistallo	appesi ad una parete	sospesi al soffitto	Altro
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	-	*	-	-	-
T4	-	-	-	-	-	*	-	√
T5	-	-	-	-	-	-	*	-
T6	*	*	*	*	*	*	*	*

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte

Categoria	Modalità di risposta		Meccanismi di danno		Sigla
A	moto attaccato	□	sollecitazioni eccessive	□	R1
	Scivolamento	□	spostamenti eccessivi	□	R2
	oscillazioni	□	urti ripetuti	□	R3
	oscillazioni	□	ribaltamento	□	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	□	sollecitazioni eccessive	□	R1
	moto attaccato	√	spostamenti eccessivi	√	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	□	Discreto	√	Scadente	□	Pessimo	□
STATO DI CONSERVAZIONE DELL'OPERA							
DIPINTI SU TELA							
TELAIO LIGNEO		Aggressione da insetti	□	Sali di rame	□	Alterazione cromatica	□
		Marcescenza	□	Macchie di ruggine	□	Carie	□
		Note: telaio non visibile					√
SUPPORTO		Lacerazioni	□	Strappi	□	Rilassamento	□
		Aggressione da insetti	□	Bruciature	□	Macchie di umidità	□
PELLICOLA PITTORICA		Distacco	√	Decoesione	□	Patina biologica	□
		Polverizzazione	□	Macchie di umidità	□	Tracce di bruciature	□
		Caduta di colore	√	Efflorescenza salina	□	Lacune	□
		Altro					□

Figure A.13. Left wall

Table A.17. Sheet "Sant'Antelmo": Identification of the artwork

Identification of the artwork						
Object	Oval-shaped Painting					
Subject	Sant'Antelmo					
Author	Filippo Balbi					
Cultural Context						
Chronology	year 1863		century		era	
Position	Church	√	Museum room	□	Palace	□
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	□	Wall sx	√	Lunette dx	□
	Lunette sx	□	Vault	□	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	□

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	200				140			
Tipologia	Amovibile			√	Inamovibile			□
	Opera isolata			□	Serie			√
	Frammento			□	Altro			□
	Note							
Precedenti restauri	Interventi documentati			□	Interventi non documentati			□
	Note							
	Rifacimenti/Aggiunte							
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	□	Cavi elettric	□
	Note							

CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC.
	Affreschi	□			Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	√		
	Arazzi	□			Arredi	□		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		

MATERIALI								
STRUTTURE DI SOSTEGNO	Fisse	√	Mobili	□	Sospese	□		
	Vetrina	□	Cavalletto	□	Mensola	□		
	Bacheca	□	Piedistallo	□	Soffitto	□		
	Parete	√	Pavimento	□	Pannello	□		
	Scaffalatura	□	Rastrelliera	□	Altro	□		
	Note							
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	□	Telaio	√	Chiodi	√		
	Corde o fili metallici	√	Base murale	□	Parchettature	□		
	Altro						□	
SUPPORTO	Tela	√	Legno	□	Metallo	□		
	Vetro	□	Carta	□	Pietra	□		
	Cuoio	□	Pergamena	□	Intonaco/Muratura	□		
Misure del supporto [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
STRUTTURE AUSILIARIE SUPPORTO	Solidale al supporto o parte integrante di esso					√	SI □	NO □
	Vincolata rigidamente					□	SI □	NO □
	Cornice	Ligena	□	Metallica			□	
		Gesso	√	Listello			□	
		Modanata	□	Dorata			□	
		Dipinta	□	Intagliata			□	
		Intarsiata	□	Altro			□	
	Telaio	Ligneo	√	Rigido			□	
		Metallico	□	Scomponibile			□	
		Mobile	□	Altro			□	
STRATI PREPARATORI	Gesso	□	Intonaco	□	Colla	□		
PELLICOLA PITTORICA	Dipinti a olio	√	Dipinti a tempera	□	Acquerelli	□		

Coefficiente d'attrito - Superficie materiali					
Alluminio su formica	0,12	Teflon su mosaico	0,10	Plexiglass su vetro	0,20
Marmo su formica	0,18	Alluminio su legno	0,37	Plexiglass su teflon	0,15
Teflon su formica	0,13	Alluminio su alluminio	0,24	Teflon su vetro	0,13
Alluminio su mosaico	0,20	Alluminio su teflon	0,23	Terracotta su plexiglass	0,30
Marmo su mosaico	0,13	Plexiglass su plexiglass	0,35	Terracotta su vetro	0,30

Classificazione dell'opera

Classificazione dell'opera in base alla tipologia

T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	□	Statue, sculture e grandi vasi
T4	√	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	□	Altro

Classificazione dell'opera in base alla tipologia di sostegno

	A				B	C		D
	Oggetti poggiati su una superficie piana				Oggetti fissati su un piedistallo	Oggetti appesi o sospesi		Altro
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	su mensole o all'interno di bacheche		appesi ad una parete	sospesi al soffitto	
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	-	*	-	-	-
T4	-	-	-	-	-	*	-	√
T5	-	-	-	-	-	-	*	-
T6	*	*	*	*	*	*	*	*

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte

Categoria	Modalità di risposta		Meccanismi di danno		Sigla
A	moto attaccato	□	sollecitazioni eccessive	□	R1
	scivolamento	□	spostamenti eccessivi	□	R2
	oscillazioni	□	urti ripetuti	□	R3
	oscillazioni	□	ribaltamento	□	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	□	sollecitazioni eccessive	□	R1
	moto attaccato	√	spostamenti eccessivi	√	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	√	Discreto	□	Scadente	□	Pessimo	□
STATO DI CONSERVAZIONE DELL'OPERA							
DIPINTI SU TELA							
TELAIO LIGNEO		Aggressione da insetti	□	Sali di rame	□	Alterazione cromatica	□
		Marcescenza	□	Macchie di ruggine	□	Carie	□
		Note: telaio non visibile					√
SUPPORTO		Lacerazioni	□	Strappi	□	Rilassamento	□
		Aggressione da insetti	□	Bruciature	□	Macchie di umidità	□
PELLICOLA PITTORICA		Distacco	□	Decoesione	□	Patina biologica	□
		Polverizzazione	□	Macchie di umidità	□	Tracce di bruciature	□
		Caduta di colore	√	Efflorescenza salina	□	Lacune	□
		Altro					□

Table A.18. Sheet "Beato Nicolò Albergati, vescovo di Bologna e cardinale": Identification of the artwork

Identification of the artwork						
Object	Oval-shaped Painting					
Subject	Beato Nicolò Albergati, vescovo di Bologna e cardinale					
Author	Filippo Balbi					
Cultural Context						
Chronology	year 1859		century		era	
Position	Church	√	Museum room	□	Palace	□
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	□	Wall sx	√	Lunette dx	□
	Lunette sx	□	Vault	□	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	□

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	200				140			
Tipologia	Amovibile			√	Inamovibile			□
	Opera isolata			□	Serie			√
	Frammento			□	Altro			□
	Note							
Precedenti restauri	Interventi documentati			□	Interventi non documentati			□
	Note							
	Rifacimenti/Aggiunte							
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	□	Cavi elettric	□
	Note							

CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC.
	Affreschi	□			Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	√		
	Arazzi	□			Arredi	□		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		

MATERIALI								
STRUTTURE DI SOSTEGNO	Fisse	√	Mobili	□	Sospese	□		
	Vetrina	□	Cavalletto	□	Mensola	□		
	Bacheca	□	Piedistallo	□	Soffitto	□		
	Parete	√	Pavimento	□	Pannello	□		
	Scaffalatura	□	Rastrelliera	□	Altro	□		
	Note							
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	□	Telaio	√	Chiodi	√		
	Corde o fili metallici	√	Base murale	□	Parchettature	□		
	Altro						□	
SUPPORTO	Tela	√	Legno	□	Metallo	□		
	Vetro	□	Carta	□	Pietra	□		
	Cuoio	□	Pergamena	□	Intonaco/Muratura	□		

Misure del supporto [cm]	**Altezza [H]**	**Profondità [P]**	**Larghezza [L]**	**Diametro [D]**

STRUTTURE AUSILIARIE SUPPORTO							
		Solidale al supporto o parte integrante di esso			√	SI □	NO □
		Vincolata rigidamente			□	SI □	NO □
	Cornice	Ligena	□	Metallica		□	
		Gesso	√	Listello		□	
		Modanata	□	Dorata		□	
		Dipinta	□	Intagliata		□	
		Intarsiata	□	Altro		□	
	Telaio	Ligneo	√	Rigido		□	
		Metallico	□	Scomponibile		□	
		Mobile	□	Altro		□	

STRATI PREPARATORI	Gesso	□	Intonaco	□	Colla	□	
PELLICOLA PITTORICA	Dipinti a olio	√	Dipinti a tempera	□	Acquerelli	□	

Coefficiente d'attrito - Superficie materiali					
Alluminio su formica	0,12	Teflon su mosaico	0,10	Plexiglass su vetro	0,20
Marmo su formica	0,18	Alluminio su legno	0,37	Plexiglass su teflon	0,15
Teflon su formica	0,13	Alluminio su alluminio	0,24	Teflon su vetro	0,13
Alluminio su mosaico	0,20	Alluminio su teflon	0,23	Terracotta su plexiglass	0,30
Marmo su mosaico	0,13	Plexiglass su plexiglass	0,35	Terracotta su vetro	0,30

Classificazione dell'opera

Classificazione dell'opera in base alla tipologia

T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	□	Statue, sculture e grandi vasi
T4	√	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	□	Altro

Classificazione dell'opera in base alla tipologia di sostegno

	A				B	C		D
	Oggetti poggiati su una superficie piana				Oggetti fissati su un piedistallo	Oggetti appesi o sospesi		Altro
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	su mensole o all'interno di bacheche		appesi ad una parete	sospesi al soffitto	
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	-	*	-	-	-
T4	-	-	-	-	-	*	-	√
T5	-	-	-	-	-	-	*	-
T6	*	*	*	*	*	*	*	*

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte

Categoria	Modalità di risposta		Meccanismi di danno		Sigla
A	moto attaccato	□	sollecitazioni eccessive	□	R1
	scivolamento	□	spostamenti eccessivi	□	R2
	oscillazioni	□	urti ripetuti	□	R3
	oscillazioni	□	ribaltamento	□	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	□	sollecitazioni eccessive	□	R1
	moto attaccato	√	spostamenti eccessivi	√	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	√	Discreto	□	Scadente	□	Pessimo	□
STATO DI CONSERVAZIONE DELL'OPERA							
DIPINTI SU TELA							
TELAIO LIGNEO		Aggressione da insetti	□	Sali di rame	□	Alterazione cromatica	□
		Marcescenza	□	Macchie di ruggine	□	Carie	□
		Note: telaio non visibile					√
SUPPORTO		Lacerazioni	□	Strappi	□	Rilassamento	□
		Aggressione da insetti	□	Bruciature	□	Macchie di umidità	□
PELLICOLA PITTORICA		Distacco	□	Decoesione	□	Patina biologica	□
		Polverizzazione	□	Macchie di umidità	□	Tracce di bruciature	□
		Caduta di colore	√	Efflorescenza salina	□	Lacune	□
		Altro					□

Table A.19. Sheet "Mosè": Identification of the artwork

Identification of the artwork						
Object	Painting					
Subject	Mosè percuote la roccia, per opera di Dio, dalla quale sgorga l'acqua per il popolo accampato nel deserto del Sinai					
Author	Filippo Balbi					
Cultural Context						
Chronology	year 1859		century		era	
Position	Church	√	Museum room	□	Palace	□
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	□	Wall sx	√	Lunette dx	□
	Lunette sx	□	Vault	□	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	□

Identificazione dell'opera							
Oggetto	Tela						
Soggetto	Mosè percuote la roccia, per opera di Dio, dalla quale sgorga l'acqua per il popolo accampato nel deserto del Sinai						
Autore	Filippo Balbi						
Ambito culturale							
Cronologia/Datazione	anno 1859		secolo		epoca		
Collocazione	Chiesa	√	Sala Museale	□	Palazzo	□	
	Spazi esterni	□	Strada/Piazza	□	Area archeologica	□	
Collocazione specifica	Parete dx	□	Parete sx	√	Lunetta dx	□	
	Lunetta sx	□	Volta	□	Cupola	□	
	Cappella laterale dx	□	Cappella laterale sx	□	Altare	□	
	Vetrina	□	Bacheca	□	Altro	□	

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	370				590			
Tipologia	Amovibile		√		Inamovibile		□	
	Opera isolata		□		Serie		□	
	Frammento		□		Altro		□	
	Note							
Precedenti restauri	Interventi documentati		□		Interventi non documentati		□	
	Note							
	Rifacimenti/Aggiunte							
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	□	Cavi elettric	□
	Note							

CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC.
	Affreschi	□			Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	√		
	Arazzi	□			Arredi	□		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		

MATERIALI						
STRUTTURE DI SOSTEGNO	Fisse	√	Mobili	□	Sospese	□
	Vetrina	□	Cavalletto	□	Mensola	□
	Bacheca	□	Piedistallo	□	Soffitto	□
	Parete	√	Pavimento	□	Pannello	□
	Scaffalatura	□	Rastrelliera	□	Altro	□
	Note					
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	√	Telaio	□	Chiodi	□
	Corde o fili metallici	√	Base murale	□	Parchettature	□
	Altro					□
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	□	Telaio	√	Chiodi	√
	Corde o fili metallici	√	Base murale	□	Parchettature	□
	Altro					□

Misure del supporto [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
STRUTTURE AUSILIARIE SUPPORTO	**Cornice**	Solidale al supporto o parte integrante di esso			√		SI □	NO □
		Vincolata rigidamente			□		SI □	NO □
		Ligena	□	Metallica			□	
		Gesso	√	Listello			□	
		Modanata	□	Dorata			√	
		Dipinta	□	Intagliata			□	
		Intarsiata	□	Altro			□	
	Telaio	Ligneo	√	Rigido			□	
		Metallico	□	Scomponibile			□	
		Mobile	□	Altro			□	
STRATI PREPARATORI	Gesso	□	Intonaco	□	Colla		□	
PELLICOLA PITTORICA	Dipinti a olio	√	Dipinti a tempera	□	Acquerelli		□	

Coefficiente d'attrito - Superficie materiali					
Alluminio su formica	0,12	Teflon su mosaico	0,10	Plexiglass su vetro	0,20
Marmo su formica	0,18	Alluminio su legno	0,37	Plexiglass su teflon	0,15
Teflon su formica	0,13	Alluminio su alluminio	0,24	Teflon su vetro	0,13
Alluminio su mosaico	0,20	Alluminio su teflon	0,23	Terracotta su plexiglass	0,30
Marmo su mosaico	0,13	Plexiglass su plexiglass	0,35	Terracotta su vetro	0,30

Classificazione dell'opera		
Classificazione dell'opera in base alla tipologia		
T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	□	Statue, sculture e grandi vasi
T4	√	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	□	Altro

Classificazione dell'opera in base alla tipologia di sostegno

	A				B	C		D
	Oggetti poggiati su una superficie piana				Oggetti fissati su un piedistallo	Oggetti appesi o sospesi		Altro
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	su mensole o all'interno di bacheche		appesi ad una parete	sospesi al soffitto	
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	-	*	-	-	-
T4	-	-	-	-	-	*	-	√
T5	-	-	-	-	-	-	*	-
T6	*	*	*	*	*	*	*	*

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte					
Categoria	**Modalità di risposta**		**Meccanismi di danno**		**Sigla**
A	moto attaccato	□	sollecitazioni eccessive	□	R1
	scivolamento	□	spostamenti eccessivi	□	R2
	oscillazioni	□	urti ripetuti	□	R3
	oscillazioni	□	ribaltamento	□	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	□	sollecitazioni eccessive	□	R1
	moto attaccato	√	spostamenti eccessivi	√	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	√	Discreto	□	Scadente	□	Pessimo	□
STATO DI CONSERVAZIONE DELL'OPERA							
DIPINTI SU TELA							
TELAIO LIGNEO		Aggressione da insetti	□	Sali di rame	□	Alterazione cromatica	□
		Marcescenza	□	Macchie di ruggine	□	Carie	□
		Note: telaio non visibile					√
SUPPORTO		Lacerazioni	□	Strappi	□	Rilassamento	□
		Aggressione da insetti	□	Bruciature	□	Macchie di umidità	□
PELLICOLA PITTORICA		Distacco	□	Decoesione	□	Patina biologica	□
		Polverizzazione	□	Macchie	√	Tracce di bruciature	□
		Caduta di colore	√	Efflorescenza salina	□	Lacune	□
		Altro					□

Figure A.14. Left wall; *San Bruno appare in sogno a Ruggero I*

Table A.20. Sheet "San Bruno appare in sogno a Ruggero I": Identification of the artwork

Identification of the artwork						
Object	Painting					
Subject	San Bruno appare in sogno a Ruggero I, conte di Sicilia					
Author	Giuseppe Battelli					
Cultural Context						
Chronology	year		century XIX		era	
Position	Church	√	Museum room	□	Palace	□
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	□	Wall sx	√	Lunette dx	□
	Lunette sx	□	Vault	□	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	□

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	246				440			
Tipologia	Amovibile			√	Inamovibile			□
	Opera isolata			□	Serie			□
	Frammento			□	Altro			□
	Note							
Precedenti restauri	Interventi documentati			□	Interventi non documentati			√
	Note							
	Rifacimenti/Aggiunte							
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	□	Cavi elettrici	□
	Note							

CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC.
	Affreschi	□			Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	√		
	Arazzi	□			Arredi	□		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		

MATERIALI								
STRUTTURE DI SOSTEGNO	Fisse	√	Mobili	□	Sospese	□		
	Vetrina	□	Cavalletto	□	Mensola	□		
	Bacheca	□	Piedistallo	□	Soffitto	□		
	Parete	√	Pavimento	□	Pannello	□		
	Scaffalatura	□	Rastrelliera	□	Altro	□		
	Note							
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	□	Telaio	√	Chiodi	√		
	Corde o fili metallici	√	Base murale	□	Parchettature	□		
	Altro						□	
SUPPORTO	Tela	√	Legno	□	Metallo	□		
	Vetro	□	Carta	□	Pietra	□		
	Cuoio	□	Pergamena	□	Intonaco/Muratura	□		

Misure del supporto [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
STRUTTURE AUSILIARIE SUPPORTO	**Cornice**	Solidale al supporto o parte integrante di esso				√	SI □	NO □
		Vincolata rigidamente				□	SI □	NO □
		Ligena	□	Metallica			□	
		Gesso	√	Listello			□	
		Modanata	□	Dorata			√	
		Dipinta	□	Intagliata			□	
		Intarsiata	□	Altro			□	
	Telaio	Ligneo	√	Rigido			□	
		Metallico	□	Scomponibile			□	
		Mobile	□	Altro			□	
STRATI PREPARATORI	Gesso	□	Intonaco	□	Colla	□		
PELLICOLA PITTORICA	Dipinti a olio	√	Dipinti a tempera	□	Acquerelli	□		

Coefficiente d'attrito - Superficie materiali					
Alluminio su formica	0,12	Teflon su mosaico	0,10	Plexiglass su vetro	0,20
Marmo su formica	0,18	Alluminio su legno	0,37	Plexiglass su teflon	0,15
Teflon su formica	0,13	Alluminio su alluminio	0,24	Teflon su vetro	0,13
Alluminio su mosaico	0,20	Alluminio su teflon	0,23	Terracotta su plexiglass	0,30
Marmo su mosaico	0,13	Plexiglass su plexiglass	0,35	Terracotta su vetro	0,30

Classificazione dell'opera		
Classificazione dell'opera in base alla tipologia		
T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	□	Statue, sculture e grandi vasi
T4	√	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	□	Altro

Classificazione dell'opera in base alla tipologia del supporto

	A				**B**	**C**		**D**
	Oggetti poggiati su una superficie piana					Oggetti appesi o sospesi		
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	su mensole o all'interno di bacheche	Oggetti fissati su un piedistallo	appesi ad una parete	sospesi al soffitto	Altro
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	-	*	-	-	-
T4	-	-	-	-	-	*	-	√
T5	-	-	-	-	-	-	*	-
T6	*	*	*	*	*	*	*	*

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte

Categoria	Modalità di risposta		Meccanismi di danno		Sigla
A	moto attaccato	□	sollecitazioni eccessive	□	R1
	Scivolamento	□	spostamenti eccessivi	□	R2
	oscillazioni	□	urti ripetuti	□	R3
	oscillazioni	□	ribaltamento	□	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	□	sollecitazioni eccessive	□	R1
	moto attaccato	√	spostamenti eccessivi	√	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	□	Discreto	√	Scadente	□	Pessimo	□
STATO DI CONSERVAZIONE DELL'OPERA							
DIPINTI SU TELA							
TELAIO LIGNEO		Aggressione da insetti	□	Sali di rame	□	Alterazione cromatica	□
		Marcescenza	□	Macchie di ruggine	□	Carie	□
		Note: telaio non visibile					√
SUPPORTO		Lacerazioni	□	Strappi	□	Rilassamento	□
		Aggressione da insetti	□	Bruciature	□	Macchie di umidità	□
PELLICOLA PITTORICA		Distacco	√	Decoesione	□	Patina biologica	□
		Polverizzazione	□	Macchie di umidità	□	Tracce di bruciature	□
		Caduta di colore	√	Efflorescenza salina	□	Lacune	□
		Altro					□

Figure A.15. Front wall; *La Vergine richiama i primi certosini di Grenoble*

Table A.21. Sheet "La Vergine richiama i primi certosini di Grenoble": Identification of the artwork

Identification of the artwork						
Object	Painting					
Subject	La Vergine richiama i primi certosini di Grenoble					
Author	Giuseppe Battelli					
Cultural Context						
Chronology	year		century XIX		era	
Position	Church	√	Museum room	□	Palace	□
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	□	Wall sx	□	Lunette dx	□
	Lunette sx	□	Vault	□	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	√

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	400				646			
Tipologia	Amovibile			√	Inamovibile			□
	Opera isolata			□	Serie			□
	Frammento			□	Altro			□
	Note							
Precedenti restauri	Interventi documentati			□	Interventi non documentati			√
	Note							
	Rifacimenti/Aggiunte							
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	□	Cavi elettric	□
	Note							

CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC.
	Affreschi	□			Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	√		
	Arazzi	□			Arredi	□		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		

MATERIALI								
STRUTTURE DI SOSTEGNO	Fisse	√	Mobili	□	Sospese	□		
	Vetrina	□	Cavalletto	□	Mensola	□		
	Bacheca	□	Piedistallo	□	Soffitto	□		
	Parete	√	Pavimento	□	Pannello	□		
	Scaffalatura	□	Rastrelliera	□	Altro	□		
	Note							
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	□	Telaio	√	Chiodi	√		
	Corde o fili metallici	√	Base murale	□	Parchettature	□		
	Altro						□	
SUPPORTO	Tela	√	Legno	□	Metallo	□		
	Vetro	□	Carta	□	Pietra	□		
	Cuoio	□	Pergamena	□	Intonaco/Muratura	□		
Misure del supporto [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
STRUTTURE AUSILIARIE SUPPORTO		Solidale al supporto o parte integrante di esso				√	SI □	NO □
		Vincolata rigidamente				□	SI □	NO □
	Cornice	Ligena	□	Metallica			□	
		Gesso	√	Listello			□	
		Modanata	□	Dorata			√	
		Dipinta	□	Intagliata			□	
		Intarsiata	□	Altro			□	
	Telaio	Ligneo	√	Rigido			□	
		Metallico	□	Scomponibile			□	
		Mobile	□	Altro			□	
STRATI PREPARATORI	Gesso	□	Intonaco	□	Colla	□		
PELLICOLA PITTORICA	Dipinti a olio	√	Dipinti a tempera	□	Acquerelli	□		

Coefficiente d'attrito - Superficie materiali					
Alluminio su formica	0,12	Teflon su mosaico	0,10	Plexiglass su vetro	0,20
Marmo su formica	0,18	Alluminio su legno	0,37	Plexiglass su teflon	0,15
Teflon su formica	0,13	Alluminio su alluminio	0,24	Teflon su vetro	0,13
Alluminio su mosaico	0,20	Alluminio su teflon	0,23	Terracotta su plexiglass	0,30
Marmo su mosaico	0,13	Plexiglass su plexiglass	0,35	Terracotta su vetro	0,30

Classificazione dell'opera

Classificazione dell'opera in base alla tipologia

T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	□	Statue, sculture e grandi vasi
T4	√	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	□	Altro

Classificazione dell'opera in base alla tipologia del supporto

	A				B	C		D
	Oggetti poggiati su una superficie piana				Oggetti fissati su un piedistallo	Oggetti appesi o sospesi		Altro
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	su mensole o all'interno di bacheche		appesi ad una parete	sospesi al soffitto	
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	-	*	-	-	-
T4	-	-	-	-	-	*	-	√
T5	-	-	-	-	-	-	*	-
T6	*	*	*	*	*	*	*	*

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte

Categoria	Modalità di risposta		Meccanismi di danno		Sigla
A	moto attaccato	□	sollecitazioni eccessive	□	R1
	Scivolamento	□	spostamenti eccessivi	□	R2
	oscillazioni	□	urti ripetuti	□	R3
	oscillazioni	□	ribaltamento	□	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	□	sollecitazioni eccessive	□	R1
	moto attaccato	√	spostamenti eccessivi	√	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	□	Discreto	√	Scadente	□	Pessimo	□
STATO DI CONSERVAZIONE DELL'OPERA							
DIPINTI SU TELA							
TELAIO LIGNEO		Aggressione da insetti	□	Sali di rame	□	Alterazione cromatica	□
		Marcescenza	□	Macchie di ruggine	□	Carie	□
		Note: telaio non visibile					√
SUPPORTO		Lacerazioni	□	Strappi	□	Rilassamento	□
		Aggressione da insetti	□	Bruciature	□	Macchie di umidità	□
PELLICOLA PITTORICA		Distacco	□	Decoesione	√	Patina biologica	□
		Polverizzazione	□	Macchie di umidità	□	Tracce di bruciature	□
		Caduta di colore	√	Efflorescenza salina	√	Lacune	□
		Altro					□

Figure A.16. Altar; *Vergine con il bambino in braccio*

Table A.22. Sheet "Vergine con il bambino in braccio": Identification of the artwork

Identification of the artwork						
Object	Painting					
Subject	Vergine con il bambino in braccio					
Author	Giuseppe Caci					
Cultural Context						
Chronology	year 1682		century		era	
Position	Church	√	Museum room	□	Palace	□
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	□	Wall sx	□	Lunette dx	□
	Lunette sx	□	Vault	□	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	√
	Showcase	□	Display case	□	Other	□

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	232				170			
Tipologia	Amovibile			√	Inamovibile			□
	Opera isolata			□	Serie			□
	Frammento			□	Altro			□
	Note							
Precedenti restauri	Interventi documentati			□	Interventi non documentati			√
	Note							
	Rifacimenti/Aggiunte							
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	□	Cavi elettrici	□
	Note							

CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC.
	Affreschi	□			Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	√		
	Arazzi	□			Arredi	□		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		

MATERIALI								
STRUTTURE DI SOSTEGNO	Fisse	√	Mobili	□	Sospese	□		
	Vetrina	□	Cavalletto	□	Mensola	□		
	Bacheca	□	Piedistallo	□	Soffitto	□		
	Parete	√	Pavimento	□	Pannello	□		
	Scaffalatura	□	Rastrelliera	□	Altro	□		
	Note							
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	□	Telaio	√	Chiodi	√		
	Corde o fili metallici	√	Base murale	□	Parchettature	□		
	Altro						□	
SUPPORTO	Tela	√	Legno	□	Metallo	□		
	Vetro	□	Carta	□	Pietra	□		
	Cuoio	□	Pergamena	□	Intonaco/Muratura	□		

Misure del supporto [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
STRUTTURE AUSILIARIE SUPPORTO	**Cornice**	Solidale al supporto o parte integrante di esso				√	SI □	NO □
		Vincolata rigidamente				□	SI □	NO □
		Ligena	□	Metallica			□	
		Gesso	√	Listello			□	
		Modanata	□	Dorata			√	
		Dipinta	□	Intagliata			□	
		Intarsiata	□	Altro			□	
	Telaio	Ligneo	√	Rigido			□	
		Metallico	□	Scomponibile			□	
		Mobile	□	Altro			□	
STRATI PREPARATORI	Gesso	□	Intonaco	□	Colla	□		
PELLICOLA PITTORICA	Dipinti a olio	√	Dipinti a tempera	□	Acquerelli	□		

Coefficiente d'attrito - Superficie materiali					
Alluminio su formica	0,12	Teflon su mosaico	0,10	Plexiglass su vetro	0,20
Marmo su formica	0,18	Alluminio su legno	0,37	Plexiglass su teflon	0,15
Teflon su formica	0,13	Alluminio su alluminio	0,24	Teflon su vetro	0,13
Alluminio su mosaico	0,20	Alluminio su teflon	0,23	Terracotta su plexiglass	0,30
Marmo su mosaico	0,13	Plexiglass su plexiglass	0,35	Terracotta su vetro	0,30

Classificazione dell'opera		
Classificazione dell'opera in base alla tipologia		
T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	□	Statue, sculture e grandi vasi
T4	√	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	□	Altro

Classificazione dell'opera in base alla tipologia del supporto

	A				**B**	**C**		**D**
	Oggetti poggiati su una superficie piana					Oggetti appesi o sospesi		
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	su mensole o all'interno di bacheche	Oggetti fissati su un piedistallo	appesi ad una parete	sospesi al soffitto	Altro
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	-	*	-	-	-
T4	-	-	-	-	-	*	-	√
T5	-	-	-	-	-	-	*	-
T6	*	*	*	*	*	*	*	*

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte

Categoria	Modalità di risposta		Meccanismi di danno		Sigla
A	moto attaccato	□	sollecitazioni eccessive	□	R1
	Scivolamento	□	spostamenti eccessivi	□	R2
	oscillazioni	□	urti ripetuti	□	R3
	oscillazioni	□	ribaltamento	□	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	□	sollecitazioni eccessive	□	R1
	moto attaccato	√	spostamenti eccessivi	√	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	√	Discreto	□	Scadente	□	Pessimo	□
STATO DI CONSERVAZIONE DELL'OPERA							
DIPINTI SU TELA							
TELAIO LIGNEO		Aggressione da insetti	□	Sali di rame	□	Alterazione cromatica	□
		Marcescenza	□	Macchie di ruggine	□	Carie	□
		Note: telaio non visibile					√
SUPPORTO		Lacerazioni	□	Strappi	□	Rilassamento	□
		Aggressione da insetti	□	Bruciature	□	Macchie di umidità	□
PELLICOLA PITTORICA		Distacco	□	Decoesione	□	Patina biologica	□
		Polverizzazione	□	Macchie di umidità	□	Tracce di bruciature	□
		Caduta di colore	□	Efflorescenza salina	□	Lacune	□
		Altro					□

Figure A.17. Vault; *La Gloria del Paradiso*

Table A.23. Sheet "La Gloria del Paradiso": Identification of the artwork

Identification of the artwork						
Object	Barrel vault frescoes					
Subject	Gloria del Paradiso					
Author	Giuseppe Caci					
Cultural Context						
Chronology	year 1683		century		era	
Position	Church	√	Museum room	□	Palace	□
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	□	Wall sx	□	Lunette dx	□
	Lunette sx	□	Vault	√	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	□

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
			2265		810			
Tipologia	Amovibile			□	Inamovibile			√
	Opera isolata			□	Serie			□
	Frammento			□	Altro			□
	Note							
Precedenti restauri	Interventi documentati			□	Interventi non documentati			√
	Note							
	Rifacimenti/Aggiunte							
	Fori	√	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	□	Cavi elettrici	□
	Note							

CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC.
	Affreschi	√			Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	□		
	Arazzi	□			Arredi	□		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		

MATERIALI							
STRUTTURE DI SOSTEGNO	Fisse	√	Mobili	□	Sospese	□	
	Vetrina	□	Cavalletto	□	Mensola	□	
	Bacheca	□	Piedistallo	□	Soffitto	√	
	Parete	□	Pavimento	□	Pannello	□	
	Scaffalatura	□	Rastrelliera	□	Altro	□	
	Note						
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	□	Telaio	□	Chiodi	□	
	Corde o fili metallici	□	Base murale	√	Parchettature	□	
	Altro					□	
SUPPORTO	Tela	□	Legno	□	Metallo	□	
	Vetro	□	Carta	□	Pietra	□	
	Cuoio	□	Pergamena	□	Intonaco/Muratura	√	
Misure del supporto [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**
STRATI PREPARATORI	Gesso	□	Intonaco	√	Colla	□	
PELLICOLA PITTORICA	Dipinti a olio	□	Dipinti a tempera	□	Acquerelli	□	

Coefficiente d'attrito - Superficie materiali					
Alluminio su formica	0,12	Teflon su mosaico	0,10	Plexiglass su vetro	0,20
Marmo su formica	0,18	Alluminio su legno	0,37	Plexiglass su teflon	0,15
Teflon su formica	0,13	Alluminio su alluminio	0,24	Teflon su vetro	0,13
Alluminio su mosaico	0,20	Alluminio su teflon	0,23	Terracotta su plexiglass	0,30
Marmo su mosaico	0,13	Plexiglass su plexiglass	0,35	Terracotta su vetro	0,30

Classificazione dell'opera

Classificazione dell'opera in base alla tipologia

T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	□	Statue, sculture e grandi vasi
T4	□	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	√	Altro

Classificazione dell'opera in base alla tipologia del supporto

	A				B	C		D
	Oggetti poggiati su una superficie piana				Oggetti fissati su un piedistallo	Oggetti appesi o sospesi		Altro
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	su mensole o all'interno di bacheche		appesi ad una parete	sospesi al soffitto	
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	-	*	-	-	-
T4	-	-	-	-	-	*	-	*
T5	-	-	-	-	-	-	*	-
T6	*	*	*	*	*	*	*	√

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte

Categoria	Modalità di risposta		Meccanismi di danno		Sigla
A	moto attaccato	□	sollecitazioni eccessive	□	R1
	Scivolamento	□	spostamenti eccessivi	□	R2
	oscillazioni	□	urti ripetuti	□	R3
	oscillazioni	□	ribaltamento	□	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	√	sollecitazioni eccessive	√	R1
	moto attaccato	□	spostamenti eccessivi	□	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	□	Discreto	√	Scadente	□	Pessimo	□
STATO DI CONSERVAZIONE DELL'OPERA							
AFFRESCHI							
INTONACO	Distacco	√	Rigonfiamento	□	Disgregazione	□	
	Deposito superficiale	□	Caduta	□	Lesioni	□	
	Fessurazioni	□	Lacune	□	Macchie di umidità	□	
	Mancanza	□	Efflorescenza salina	√	Altro	□	
PELLICOLA PITTORICA	Decoesione	□	Macchie di umidità	√	Polverizzazione	√	
	Caduta di colore	□	Patina biologica	□	Distacchi a scaglie	□	
	Altro					□	

Figure A.18. Choir of the Fathers

Table A.24. Sheet "Coro dei Padri": Identification of the artwork

Identification of the artwork						
Object	Coro ligneo					
Subject	Mostri animaleschi con coda di drago nei braccioli e i piccoli leggii mobili					
Author	Mastro Jacob					
Cultural Context						
Chronology	year 1546-1548		century		era	
Position	Church	√	Museum room	□	Palace	□
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	□	Wall sx	□	Lunette dx	□
	Lunette sx	□	Vault	□	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	√

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	100				80			
Tipologia	Amovibile			□	Inamovibile			√
	Opera isolata			□	Serie			□
	Frammento			□	Altro			□
	Note							
Precedenti restauri	Interventi documentati			□	Interventi non documentati			□
	Note							
	Rifacimenti/Aggiunte							
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	□	Cavi elettric	□
	Note							

CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC.
	Affreschi	□			Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	□		
	Arazzi	□			Arredi	√		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		

MATERIALI						
STRUTTURE DI SOSTEGNO	Fisse	√	Mobili	□	Sospese	□
	Vetrina	□	Cavalletto	□	Mensola	□
	Bacheca	□	Piedistallo	□	Soffitto	□
	Parete	√	Pavimento	√	Pannello	□
	Scaffalatura	□	Rastrelliera	□	Altro	□
	Note					
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	□	Telaio	√	Chiodi	√
	Corde o fili metallici	□	Base murale	□	Parchettature	□
	Altro					□
SUPPORTO	Tela	□	Legno	√	Metallo	□
	Vetro	□	Carta	□	Pietra	□
	Cuoio	□	Pergamena	□	Intonaco/Muratura	□
Misure del supporto [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**	**Diametro [D]**
	297		203		1100	

Coefficiente d'attrito - Superficie materiali					
Alluminio su formica	0,12	Teflon su mosaico	0,10	Plexiglass su vetro	0,20
Marmo su formica	0,18	Alluminio su legno	0,37	Plexiglass su teflon	0,15
Teflon su formica	0,13	Alluminio su alluminio	0,24	Teflon su vetro	0,13
Alluminio su mosaico	0,20	Alluminio su teflon	0,23	Terracotta su plexiglass	0,30
Marmo su mosaico	0,13	Plexiglass su plexiglass	0,35	Terracotta su vetro	0,30

Classificazione dell'opera		
Classificazione dell'opera in base alla tipologia		
T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	□	Statue, sculture e grandi vasi
T4	□	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	√	Altro

Classificazione dell'opera in base alla tipologia del supporto

	A				B	C		D
	Oggetti poggiati su una superficie piana				Oggetti fissati su un piedistallo	Oggetti appesi o sospesi		Altro
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	su mensole o all'interno di bacheche		appesi ad una parete	sospesi al soffitto	
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	-	*	-	-	-
T4	-	-	-	-	-	*	-	*
T5	-	-	-	-	-	-	*	-
T6	√	*	*	*	*	*	*	*

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte

Categoria	Modalità di risposta		Meccanismi di danno		Sigla
A	moto attaccato	□	sollecitazioni eccessive	□	R1
	scivolamento	□	spostamenti eccessivi	□	R2
	oscillazioni	□	urti ripetuti	□	R3
	oscillazioni	□	ribaltamento	□	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	√	sollecitazioni eccessive	√	R1
	moto attaccato	□	spostamenti eccessivi	□	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	√	Discreto	□	Scadente	□	Pessimo	□
STATO DI CONSERVAZIONE DELL'OPERA							
SCULTURE, ALTORILIEVI, BASSORILIEVI IN LEGNO							
SUPPORTO		Aggressione da insetti	□	Deformazione	□	Mancanze (mutilazioni)	□
		Bruciature	□	Marcescenza	□	Macchie di umidità	□
		Altro					□
PELLICOLA PITTORICA		Caduta di colore	□	Distacco	□	Decoesione	□
		Polverizzazione	□	Depositi superficiali	□	Tracce di bruciature	□
		Lacune	□	Efflorescenza	□	Integrazioni	□
		Altro					□

Figure A.19. Choir of *Conversi*

Table A.25. Sheet "Coro dei Conversi": Identification of the artwork

Identification of the artwork						
Object	Coro ligneo					
Subject						
Author	Frate Stefano; mastri Umberto e Melchiorre Siodoto di Arpino					
Cultural Context						
Chronology	year 1688-1890		century		era	
Position	Church	√	Museum room	□	Palace	□
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	□	Wall sx	□	Lunette dx	□
	Lunette sx	□	Vault	□	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	√

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	100				80			
Tipologia	Amovibile			□	Inamovibile			√
	Opera isolata			□	Serie			□
	Frammento			□	Altro			□
	Note							
Precedenti restauri	Interventi documentati			□	Interventi non documentati			□
	Note							
	Rifacimenti/Aggiunte							
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	□	Cavi elettric	□
	Note							

CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC.
	Affreschi	□			Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	□		
	Arazzi	□			Arredi	√		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		

MATERIALI						
STRUTTURE DI SOSTEGNO	Fisse	√	Mobili	□	Sospese	□
	Vetrina	□	Cavalletto	□	Mensola	□
	Bacheca	□	Piedistallo	□	Soffitto	□
	Parete	√	Pavimento	√	Pannello	□
	Scaffalatura	□	Rastrelliera	□	Altro	□
	Note					
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	□	Telaio	√	Chiodi	√
	Corde o fili metallici	□	Base murale	□	Parchettature	□
	Altro					□
SUPPORTO	Tela	□	Legno	√	Metallo	□
	Vetro	□	Carta	□	Pietra	□
	Cuoio	□	Pergamena	□	Intonaco/Muratura	□
Misure del supporto [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**	**Diametro [D]**
	297		148		642	

Coefficiente d'attrito - Superficie materiali					
Alluminio su formica	0,12	Teflon su mosaico	0,10	Plexiglass su vetro	0,20
Marmo su formica	0,18	Alluminio su legno	0,37	Plexiglass su teflon	0,15
Teflon su formica	0,13	Alluminio su alluminio	0,24	Teflon su vetro	0,13
Alluminio su mosaico	0,20	Alluminio su teflon	0,23	Terracotta su plexiglass	0,30
Marmo su mosaico	0,13	Plexiglass su plexiglass	0,35	Terracotta su vetro	0,30

Classificazione dell'opera		
Classificazione dell'opera in base alla tipologia		
T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	□	Statue, sculture e grandi vasi
T4	□	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	√	Altro

Classificazione dell'opera in base alla tipologia del supporto

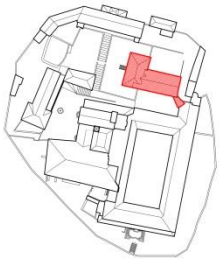
	A				B	C		D
	Oggetti poggiati su una superficie piana				Oggetti fissati su un piedistallo	Oggetti appesi o sospesi		Altro
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	su mensole o all'interno di bacheche		appesi ad una parete	sospesi al soffitto	
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	-	*	-	-	-
T4	-	-	-	-	-	*	-	*
T5	-	-	-	-	-	-	*	-
T6	√	*	*	*	*	*	*	*

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte

Categoria	Modalità di risposta		Meccanismi di danno		Sigla
A	moto attaccato	√	sollecitazioni eccessive	√	R1
	scivolamento	□	spostamenti eccessivi	□	R2
	oscillazioni	□	urti ripetuti	□	R3
	oscillazioni	□	ribaltamento	□	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	√	sollecitazioni eccessive	√	R1
	moto attaccato	□	spostamenti eccessivi	□	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	√	Discreto	□	Scadente	□	Pessimo	□
STATO DI CONSERVAZIONE DELL'OPERA							
SCULTURE, ALTORILIEVI, BASSORILIEVI IN LEGNO							
SUPPORTO		Aggressione da insetti	□	Deformazione	□	Mancanze (mutilazioni)	□
		Bruciature	□	Marcescenza	□	Macchie di umidità	□
		Altro					□
PELLICOLA PITTORICA		Caduta di colore	□	Distacco	□	Decoesione	□
		Polverizzazione	□	Depositi superficiali	□	Tracce di bruciature	□
		Lacune	□	Efflorescenza	□	Integrazioni	□
		Altro					□

QUADRO D'INSIEME



PIANTA QUOTA +3,90 m

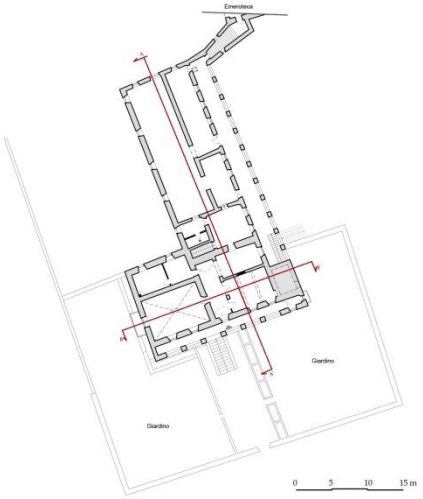


FOTO D'INQUADRAMENTO

Identificazione dell'edificio				**Scheda n°**	2	**Data**	18/03/2014		
Regione	Lazio			**Complesso edilizio composto da**			4	**corpi di fabbrica isolati**	
							2	**corpi di fabbrica aggregati**	
Provincia	Frosinone			**Codice identificativo**					
Comune	Collepardo			**Dati Catastali**		**Foglio**		**Allegato**	
				Particelle					
Frazione/Località	Trisulti			**Posizione edificio**		1 √ Isolato	2 ○ Interno	3 ○ D'estremità	4 ○ D'angolo
Indirizzo	via Trisulti			**Coordinate geografiche**					
				E	13.39813				**Fuso**
Num. Civico	20	**C.A.P.**	03010	**N**	41.78007				
Denominazione edificio	Certosa di Trisulti - Farmacia								
Proprietario	Mibac/Diocesi								
Utilizzatore	Mibac/Diocesi								

Dati dimensionali ed età costruzione/ristrutturazione

N° Piani totali interrati		Altezza media di piano [m]		Superficie media di piano [m^2]		Volume oggetto di verifica [m^3]		D	Anno di progettazione	1204
A	–	B	3,5	C	632,6	H	2214,03	E	Anno di ultimazione della costruzione	1770
F	○ Nessun intervento eseguito sulla struttura dopo la costruzione									
G				G1	○ Adeg.	G2	○ Miglior.	G3	√ Altro	

Materiale strutturale principale della struttura verticale

Strutture verticali / Strutture orizzontali	Non identificato	Strutture in muratura						
		A tessitura irregolare e di cattiva qualità		A tessitura regolare e di buona qualità		Pilastri isolati	Mista	Rinforzata
		Senza catene o cordoli	Con catene o cordoli	Senza catene o cordoli	Con catene o cordoli			
	A	B	C	D	E	F	G	H
Non identificato	○	□	□	□	□	SI	□	□
Volte senza catene	□	□	□	√	□	○	G1	H1
Volte con catene	□	□	□	□	□		□	□
Travi con soletta deformabile	□	□	□	□	□	NO	G2	H2
Travi con soletta semirigida	□	□	□	√	□	√	□	□
Travi con soletta rigida	□	□	□	□	□		G3	H3

Regolarità	**Non regolare**	**Regolare**	**Copertura**		
	A	B			
Forma pianta ed elevazione	○	√	1	○	Spingente pesante
			2	○	Non spingente pesante
Disposizione tamponature	○	○	3	○	Spingente leggera
			4	√	Non spingente

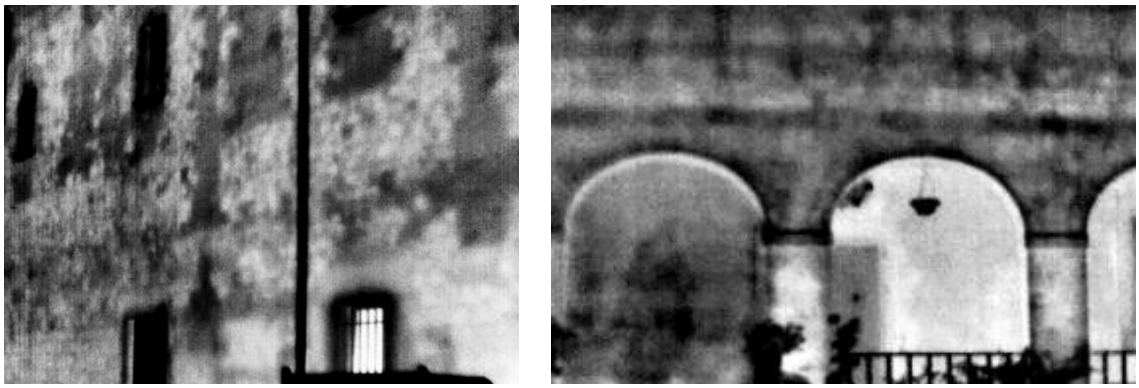


Figure A.20. Results of thermography

ELEMENTI COSTITUTIVI								
MATERIALE	Arenaria	□	Calcare	√	Tufo	□	Calcarenite	□
	Mattoni cotti	□	Mattoni crudi	□	Vario di reimpiego	□	Altro	□
LAVORAZIONE	Assente (ciottoli)	□	Sbozzatura	√	A spigoli finiti	□	A conci squadrati	√
DIMENSIONE (diagonale elemento)	Piccole (< 15 cm)	□	Medie (15 - 25 cm)		√	Grandi (> 25 cm)		□
STATO DI CONSERVAZIONE E QUALITA'	Pessimo	□	Discreto		□	Buono		□
MALTA								
TIPO	Di calce aerea	□	Di calce idraulica	□	Cementizia	□	Altro	√
STATO DI CONSERVAZIONE E CONSISTENZA	Incoerente	□	Friabile		□	Tenace		□
FUNZIONE	Allettamento	√	Riempimento		□	Stilatura		√
POSA IN OPERA DEGLI ELEMENTI								
TESSITURA DEI PARAMENTI								
APPARECCHIATURA	Disordinata	□	Corsi irregolari		√	Corsi orizzontali		□
POSA DEGLI ELEMENTI	Casuale	□	A lisca di pesce	□	Orizzontale/Verticale	√	Orizzontale	□
RICORSI O LISTATURA	Assenti	□	In mattoni		√	Altro		□
ZEPPE O SCAGLIE	Assenti	□	In pietra		√	In cotto		□
SEZIONE TRASVERSALE								
TIPOLOGIA	Paramento unico	√	Due paramenti accostati		□	Due paramenti ammorsati		□
	A sacco (incoerente)	□	A sacco (coerente)		□	Paramento aggiunto		□
SPESSORI	Totale	□	Paramento esterno		□	Paramento interno		□
PRESENZA SIGNIFICATIVA DI VUOTI		□	**PRESENZA DI DIATONI**					□
INTONACO								
STATO ATTUALE	Muratura faccia a vista	□	Mancante	□	In parte mancante	□	Presente	√
STATO DI CONSERVAZIONE E CONSISTENZA	Degradato	√	Fessurato		□	Buono		□
COLLEGAMENTI TRA LE PARETI MURARIE								
ANGOLATE								
TIPOLOGIA	Ammorsamento scadente	□	Collegamenti irregolari		□	Alternanza regolare		√
ELEMENTI COSTITUTIVI	Analoghi alla muratura	□	Di dimensione maggiore		√	A conci squadrati		□
MARTELLI								
TIPOLOGIA	Assenza di collegamento	□	Ammorsamento scadente		□	Collegamenti efficaci		□
DIFFERENTE TIPOLOGIA DEI MURI DI SPINA		□	**FREQUENTE PRESENZA DI CATENE**					□
INTERVENTI DI CONSOLIDAMENTO								
ALLA MURATURA	Nessuno	□	Scuci-cuci in mattoni		□	Scuci-cuci in pietra		□
	Stilatura dei giunti	□	Iniezioni di malta		□	Intonaco armato		□
AI COLLEGAMENTI	Nessuno	√	Tamponatura di aperture	□	Collegamento travi	□	Catene	□
	Cuciture armate	□	Cordoli in muratura	□	Cordoli in c.a.	√	Orizzontamenti rigidi	□

Figure A.21. Frescoes of the hallway

Table A.26. Sheet "Frescoes of the hallway": Identification of the artwork

Identification of the artwork						
Object	Frescoes of the hallway					
Subject	Caricatura					
Author	Filippo Balbi					
Cultural Context						
Chronology	year 1861-1863		century XVIII		era	
Position	Church	□	Museum room	√	Palace	□
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	□	Wall sx	√	Lunette dx	□
	Lunette sx	□	Vault	□	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	□

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	2,96				8,05			
Tipologia	Amovibile			□	Inamovibile			√
	Opera isolata			□	Serie			□
	Frammento			□	Altro			□
	Note							
Precedenti restauri	Interventi documentati			√	Interventi non documentati			□
	Note							
	Rifacimenti/Aggiunte							
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	□	Cavi elettrici	□
	Note							

CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC.
	Affreschi	√			Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	□		
	Arazzi	□			Arredi	□		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		

MATERIALI						
STRUTTURE DI SOSTEGNO	Fisse	√	Mobili	□	Sospese	□
	Vetrina	□	Cavalletto	□	Mensola	□
	Bacheca	□	Piedistallo	□	Soffitto	□
	Parete	√	Pavimento	□	Pannello	□
	Scaffalatura	□	Rastrelliera	□	Altro	□
	Note					
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	□	Telaio	□	Chiodi	□
	Corde o fili metallici	□	Base murale	√	Parchettature	□
	Altro					□
SUPPORTO	Tela	□	Legno	□	Metallo	□
	Vetro	□	Carta	□	Pietra	□
	Cuoio	□	Pergamena	□	Intonaco/Muratura	√
Misure del supporto [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**	**Diametro [D]**
STRATI PREPARATORI	Gesso	□	Intonaco	√	Colla	□
PELLICOLA PITTORICA	Dipinti a olio	√	Dipinti a tempera	□	Acquerelli	□

Coefficiente d'attrito - Superficie materiali					
Alluminio su formica	0,12	Teflon su mosaico	0,10	Plexiglass su vetro	0,20
Marmo su formica	0,18	Alluminio su legno	0,37	Plexiglass su teflon	0,15
Teflon su formica	0,13	Alluminio su alluminio	0,24	Teflon su vetro	0,13
Alluminio su mosaico	0,20	Alluminio su teflon	0,23	Terracotta su plexiglass	0,30
Marmo su mosaico	0,13	Plexiglass su plexiglass	0,35	Terracotta su vetro	0,30

Classificazione dell'opera		
Classificazione dell'opera in base alla tipologia		
T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	□	Statue, sculture e grandi vasi
T4	□	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	√	Altro

Classificazione dell'opera in base alla tipologia del supporto

	A				B	C		D
	Oggetti poggiati su una superficie piana				Oggetti fissati su un piedistallo	Oggetti appesi o sospesi		Altro
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	su mensole o all'interno di bacheche		appesi ad una parete	sospesi al soffitto	
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	-	*	-	-	-
T4	-	-	-	-	-	*	-	*
T5	-	-	-	-	-	-	*	-
T6	*	*	*	*	*	*	*	√

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte					
Categoria	**Modalità di risposta**		**Meccanismi di danno**		**Sigla**
A	moto attaccato	□	sollecitazioni eccessive	□	R1
	Scivolamento	□	spostamenti eccessivi	□	R2
	Oscillazioni	□	urti ripetuti	□	R3
	Oscillazioni	□	ribaltamento	□	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	Oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	√	sollecitazioni eccessive	√	R1
	moto attaccato	□	spostamenti eccessivi	□	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	√	Discreto	□	Scadente	□	Pessimo	□
STATO DI CONSERVAZIONE DELL'OPERA							
AFFRESCHI							
INTONACO		Distacco	□	Rigonfiamento	□	Disgregazione	□
		Deposito superficiale	□	Caduta	□	Lesioni	□
		Fessurazioni	□	Lacune	□	Macchie di umidità	□
		Mancanza	□	Efflorescenza salina	□	Altro	□
PELLICOLA PITTORICA		Decoesione	□	Macchie di umidità	□	Polverizzazione	□
		Caduta di colore	□	Patina biologica	□	Distacchi a scaglie	□
		Altro					□

Figure A.22. Salottino Balbi

Table A.27. Sheet "Salottino Balbi": Identification of the artwork

Identification of the artwork						
Object	Frescoes Salottino Balbi					
Subject						
Author	Filippo Balbi					
Cultural Context						
Chronology	year 1861-1863		century XVIII		era	
Position	Church	□	Museum room	√	Palace	□
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	□	Wall sx	□	Lunette dx	□
	Lunette sx	□	Vault	□	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	√

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	3,60				0,90			
Tipologia	Amovibile			□	Inamovibile			√
	Opera isolata			□	Serie			□
	Frammento			□	Altro			□
	Note							
Precedenti restauri	Interventi documentati			√	Interventi non documentati			□
	Note							
	Rifacimenti/Aggiunte							
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	□	Cavi elettrici	□
	Note							

CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC.
	Affreschi	√			Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	□		
	Arazzi	□			Arredi	□		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		

MATERIALI						
STRUTTURE DI SOSTEGNO	Fisse	√	Mobili	□	Sospese	□
	Vetrina	□	Cavalletto	□	Mensola	□
	Bacheca	□	Piedistallo	□	Soffitto	□
	Parete	√	Pavimento	□	Pannello	□
	Scaffalatura	□	Rastrelliera	□	Altro	□
	Note					
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	□	Telaio	□	Chiodi	□
	Corde o fili metallici	□	Base murale	√	Parchettature	□
	Altro					□
SUPPORTO	Tela	□	Legno	□	Metallo	□
	Vetro	□	Carta	□	Pietra	□
	Cuoio	□	Pergamena	□	Intonaco/Muratura	√
Misure del supporto [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**	**Diametro [D]**
STRATI PREPARATORI	Gesso	□	Intonaco	√	Colla	□
PELLICOLA PITTORICA	Dipinti a olio	√	Dipinti a tempera	□	Acquerelli	□

Coefficiente d'attrito - Superficie materiali					
Alluminio su formica	0,12	Teflon su mosaico	0,10	Plexiglass su vetro	0,20
Marmo su formica	0,18	Alluminio su legno	0,37	Plexiglass su teflon	0,15
Teflon su formica	0,13	Alluminio su alluminio	0,24	Teflon su vetro	0,13
Alluminio su mosaico	0,20	Alluminio su teflon	0,23	Terracotta su plexiglass	0,30
Marmo su mosaico	0,13	Plexiglass su plexiglass	0,35	Terracotta su vetro	0,30

Classificazione dell'opera		
Classificazione dell'opera in base alla tipologia		
T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	□	Statue, sculture e grandi vasi
T4	□	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	√	Altro

Classificazione dell'opera in base alla tipologia del supporto

	A				B	C		D
	Oggetti poggiati su una superficie piana				Oggetti fissati su un piedistallo	Oggetti appesi o sospesi		Altro
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	su mensole o all'interno di bacheche		appesi ad una parete	sospesi al soffitto	
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	-	*	-	-	-
T4	-	-	-	-	-	*	-	*
T5	-	-	-	-	-	-	*	-
T6	*	*	*	*	*	*	*	√

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte

Categoria	Modalità di risposta		Meccanismi di danno		Sigla
A	moto attaccato	□	sollecitazioni eccessive	□	R1
	Scivolamento	□	spostamenti eccessivi	□	R2
	Oscillazioni	□	urti ripetuti	□	R3
	Oscillazioni	□	ribaltamento	□	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	Oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	√	sollecitazioni eccessive	√	R1
	moto attaccato	□	spostamenti eccessivi	□	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	√	Discreto	□	Scadente	□	Pessimo	□
STATO DI CONSERVAZIONE DELL'OPERA							
AFFRESCHI							
INTONACO		Distacco	□	Rigonfiamento	□	Disgregazione	□
		Deposito superficiale	□	Caduta	□	Lesioni	□
		Fessurazioni	□	Lacune	□	Macchie di umidità	□
		Mancanza	□	Efflorescenza salina	□	Altro	□
PELLICOLA PITTORICA		Decoesione	□	Macchie di umidità	□	Polverizzazione	□
		Caduta di colore	□	Patina biologica	□	Distacchi a scaglie	□
		Altro					□

Figure A.23. Vault of the pharmacy

Table A.28. Sheet "Vault of the pharmacy": Identification of the artwork

Identification of the artwork						
Object	Vault frescoes of Speziera					
Subject	Trompe-l'oeil di ispirazione pomepiana					
Author	Giacomo Manco					
Cultural Context						
Chronology	year 1788		century XVIII		era	
Position	Church	□	Museum room	√	Palace	□
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	□	Wall sx	□	Lunette dx	□
	Lunette sx	□	Vault	√	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	□

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
			8,12		5,90			
Tipologia	Amovibile			□	Inamovibile			√
	Opera isolata			□	Serie			□
	Frammento			□	Altro			□
	Note							
Precedenti restauri	Interventi documentati			√	Interventi non documentati			□
	Note							
	Rifacimenti/Aggiunte							
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	□	Cavi elettrici	□
	Note							

CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC.
	Affreschi	√			Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	□		
	Arazzi	□			Arredi	□		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		

MATERIALI						
STRUTTURE DI SOSTEGNO	Fisse	√	Mobili	□	Sospese	□
	Vetrina	□	Cavalletto	□	Mensola	□
	Bacheca	□	Piedistallo	□	Soffitto	√
	Parete	□	Pavimento	□	Pannello	□
	Scaffalatura	□	Rastrelliera	□	Altro	□
	Note					
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	□	Telaio	□	Chiodi	□
	Corde o fili metallici	□	Base murale	√	Parchettature	□
	Altro					□
SUPPORTO	Tela	□	Legno	□	Metallo	□
	Vetro	□	Carta	□	Pietra	□
	Cuoio	□	Pergamena	□	Intonaco/Muratura	√
Misure del supporto [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**	**Diametro [D]**
STRATI PREPARATORI	Gesso	□	Intonaco		√ Colla	□
PELLICOLA PITTORICA	Dipinti a olio	√	Dipinti a tempera		□ Acquerelli	□

Coefficiente d'attrito - Superficie materiali					
Alluminio su formica	0,12	Teflon su mosaico	0,10	Plexiglass su vetro	0,20
Marmo su formica	0,18	Alluminio su legno	0,37	Plexiglass su teflon	0,15
Teflon su formica	0,13	Alluminio su alluminio	0,24	Teflon su vetro	0,13
Alluminio su mosaico	0,20	Alluminio su teflon	0,23	Terracotta su plexiglass	0,30
Marmo su mosaico	0,13	Plexiglass su plexiglass	0,35	Terracotta su vetro	0,30

Classificazione dell'opera		
Classificazione dell'opera in base alla tipologia		
T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	□	Statue, sculture e grandi vasi
T4	□	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	√	Altro

Classificazione dell'opera in base alla tipologia del supporto

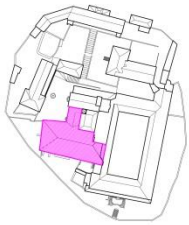
	A				B	C		D
	Oggetti poggiati su una superficie piana				Oggetti fissati su un piedistallo	Oggetti appesi o sospesi		Altro
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	su mensole o all'interno di bacheche		appesi ad una parete	sospesi al soffitto	
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	-	*	-	-	-
T4	-	-	-	-	-	*	-	*
T5	-	-	-	-	-	-	*	-
T6	*	*	*	*	*	*	*	√

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte

Categoria	Modalità di risposta		Meccanismi di danno		Sigla
A	moto attaccato	□	sollecitazioni eccessive	□	R1
	Scivolamento	□	spostamenti eccessivi	□	R2
	Oscillazioni	□	urti ripetuti	□	R3
	Oscillazioni	□	ribaltamento	□	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	Oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	√	sollecitazioni eccessive	√	R1
	moto attaccato	□	spostamenti eccessivi	□	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	√	Discreto	□	Scadente	□	Pessimo	□
STATO DI CONSERVAZIONE DELL'OPERA							
AFFRESCHI							
INTONACO		Distacco	□	Rigonfiamento	□	Disgregazione	□
		Deposito superficiale	□	Caduta	□	Lesioni	□
		Fessurazioni	□	Lacune	□	Macchie di umidità	□
		Mancanza	□	Efflorescenza salina	□	Altro	□
PELLICOLA PITTORICA		Decoesione	□	Macchie di umidità	□	Polverizzazione	□
		Caduta di colore	□	Patina biologica	□	Distacchi a scaglie	□
		Altro					□

QUADRO D'INSIEME



PIANTA QUOTA +1.50 m

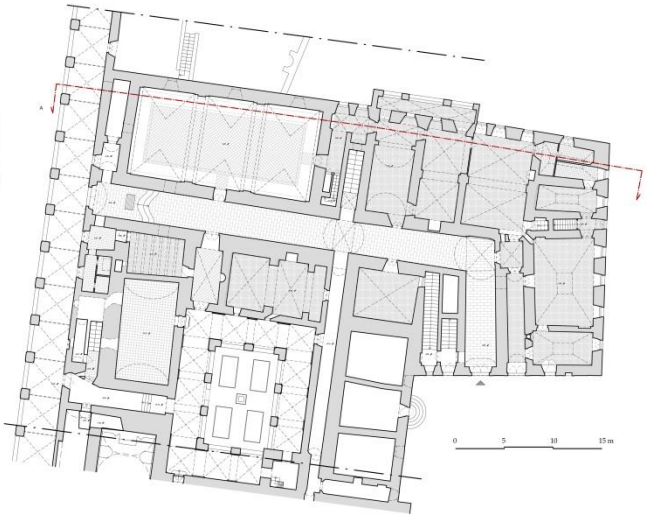


FOTO D'INQUADRAMENTO

Identificazione dell'edificio				**Scheda n°**	3	**Data**	18/03/2014				
Regione	Lazio			**Complesso edilizio composto da**			4	**corpi di fabbrica isolati**			
							2	**corpi di fabbrica aggregati**			
Provincia	Frosinone			**Codice identificativo**							
Comune	Collepardo			**Dati Catastali**		**Foglio**		**Allegato**			
				Particelle							
Frazione/Località	Trisulti			**Posizione edificio**		1 √ Isolato	2 ○ Interno	3 ○ D'estremità	4 ○ D'angolo		
Indirizzo	via Trisulti			**Coordinate geografiche (ED50 - UTM fuso 32 - 33)**							
				E	13.39813				**Fuso**		
Num. Civico	20	**C.A.P.**	03010	**N**	41.78007						
Denominazione edificio	Certosa di Trisulti - Refettorio										
Proprietario	Mibac/Diocesi										
Utilizzatore	Mibac/Diocesi										

Dati dimensionali ed età costruzione/ristrutturazione									
N° Piani totali interrati o semi interrati		Altezza media di piano [m]		Superficie media di piano [m^2]		Volume oggetto di verifica [m^3]		D	Anno di progettazione	1204
A	2	B	3,90	C	1572	H	6130,8	E	Anno di ultimazione della costruzione	600-'700
F	○ Nessun intervento eseguito sulla struttura dopo la costruzione									
G	1936			G1	○ Adeg.	G2	√ Miglior.		G3	√ Altro

Materiale strutturale principale della struttura verticale

Strutture verticali \ Strutture orizzontali	Non identificato	Strutture in muratura						
		A tessitura irregolare e di cattiva qualità		A tessitura regolare e di buona qualità		Pilastri isolati	Mista	Rinforzata
		Senza catene o cordoli	Con catene o cordoli	Senza catene o cordoli	Con catene o cordoli			
	A	B	C	D	E	F	G	H
Non identificato	○	□	□	□	□	SI	□	□
Volte senza catene	□	□	□	√	□	○	G1	H1
Volte con catene	□	□	□	□	□		□	□
Travi con soletta deformabile	□	□	□	√	□	NO	G2	H2
Travi con soletta semirigida	□	□	□	□	□	○	□	□
Travi con soletta rigida	□	□	□	□	□		G3	H3

Regolarità	**Non regolare**	**Regolare**	**Copertura**		
	A	B			
Forma pianta ed elevazione	○	√	1	○	Spingente pesante
			2	○	Non spingente pesante
Disposizione tamponature	○	○	3	○	Spingente leggera
			4	√	Non spingente

Figure A.24. Results of thermography

ELEMENTI COSTITUTIVI								
MATERIALE	Arenaria	□	Calcare	√	Tufo	□	Calcarenite	□
	Mattoni cotti	□	Mattoni crudi	□	Vario di reimpiego	□	Altro	□
LAVORAZIONE	Assente (ciottoli)	□	Sbozzatura	√	A spigoli finiti	□	A conci squadrati	□
DIMENSIONE (diagonale elemento)	Piccole (< 15 cm)	□	Medie (15 - 25 cm)		√	Grandi (> 25 cm)		□
STATO DI CONSERVAZIONE E QUALITA'	Pessimo	□	Discreto		□	Buono		√
MALTA								
TIPO	Di calce aerea	□	Di calce idraulica	□	Cementizia	□	Altro	√
STATO DI CONSERVAZIONE E CONSISTENZA	Incoerente	□	Friabile		□	Tenace		□
FUNZIONE	Allettamento	√	Riempimento		□	Stilatura		√
POSA IN OPERA DEGLI ELEMENTI								
TESSITURA DEI PARAMENTI								
APPARECCHIATURA	Disordinata	□	Corsi irregolari		√	Corsi orizzontali		√□
POSA DEGLI ELEMENTI	Casuale	□	A lisca di pesce	□	Orizzontale/Verticale	√	Orizzontale	□
RICORSI O LISTATURA	Assenti	√	In mattoni		□	Altro		□
ZEPPE O SCAGLIE	Assenti	□	In pietra		√	In cotto		□
SEZIONE TRASVERSALE								
TIPOLOGIA	Paramento unico	√	Due paramenti accostati		□	Due paramenti ammorsati		□
	A sacco (incoerente)	□	A sacco (coerente)		□	Paramento aggiunto		□
SPESSORI	Totale	□	Paramento esterno		□	Paramento interno		□
PRESENZA SIGNIFICATIVA DI VUOTI		□	**PRESENZA DI DIATONI**					□
INTONACO								
STATO ATTUALE	Muratura faccia a vista	□	Mancante	□	In parte mancante	□	Presente	√
STATO DI CONSERVAZIONE E CONSISTENZA	Degradato	√	Fessurato		□	Buono		□
COLLEGAMENTI TRA LE PARETI MURARIE								
ANGOLATE								
TIPOLOGIA	Ammorsamento scadente	□	Collegamenti irregolari		□	Alternanza regolare		√
ELEMENTI COSTITUTIVI	Analoghi alla muratura	□	Di dimensione maggiore		√	A conci squadrati		□
MARTELLI								
TIPOLOGIA	Assenza di collegamento	□	Ammorsamento scadente		□	Collegamenti efficaci		√
DIFFERENTE TIPOLOGIA DEI MURI DI SPINA		□	**FREQUENTE PRESENZA DI CATENE**					□
INTERVENTI DI CONSOLIDAMENTO								
ALLA MURATURA	Nessuno	√	Scuci-cuci in mattoni		□	Scuci-cuci in pietra		□
	Stilatura dei giunti	□	Iniezioni di malta		□	Intonaco armato		□
AI COLLEGAMENTI	Nessuno	□	Tamponatura di aperture	√	Collegamento travi	□	Catene	□
	Cuciture armate	□	Cordoli in muratura	□	Cordoli in c.a.	□	Orizzontamenti rigidi	□

Figure A.25. Backrest in walnut

Table A.29. Sheet "Backrest in walnut": Identification of the artwork

Identification of the artwork						
Object	Backrest in walnut with fixed seats					
Subject						
Author	Tommaso Catrani					
Cultural Context						
Chronology	year 1766-1770		century		era	
Position	Church	□	Museum room	□	Palace	√
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	□	Wall sx	□	Lunette dx	□
	Lunette sx	□	Vault	□	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	√

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	90		73		77			
Tipologia	Amovibile			□	Inamovibile			√
	Opera isolata			□	Serie			□
	Frammento			□	Altro			□
	Note							
Precedenti restauri	Interventi documentati			□	Interventi non documentati			□
	Note							
	Rifacimenti/Aggiunte							
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	□	Cavi elettrici	□
	Note							

CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC.
	Affreschi	□			Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	□		
	Arazzi	□			Arredi	√		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		

MATERIALI						
STRUTTURE DI SOSTEGNO	Fisse	√	Mobili	□	Sospese	□
	Vetrina	□	Cavalletto	□	Mensola	□
	Bacheca	□	Piedistallo	□	Soffitto	□
	Parete	√	Pavimento	√	Pannello	□
	Scaffalatura	□	Rastrelliera	□	Altro	□
	Note					
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	□	Telaio	√	Chiodi	√
	Corde o fili metallici	□	Base murale	□	Parchettature	□
	Altro					□
SUPPORTO	Tela	□	Legno	√	Metallo	□
	Vetro	□	Carta	□	Pietra	□
	Cuoio	□	Pergamena	□	Intonaco/Muratura	□

Misure del supporto [cm]	**Altezza [H]**	**Profondità [P]**	**Larghezza [L]**	**Diametro [D]**
	231	145	1900	

Coefficiente d'attrito - Superficie materiali					
Alluminio su formica	0,12	Teflon su mosaico	0,10	Plexiglass su vetro	0,20
Marmo su formica	0,18	Alluminio su legno	0,37	Plexiglass su teflon	0,15
Teflon su formica	0,13	Alluminio su alluminio	0,24	Teflon su vetro	0,13
Alluminio su mosaico	0,20	Alluminio su teflon	0,23	Terracotta su plexiglass	0,30
Marmo su mosaico	0,13	Plexiglass su plexiglass	0,35	Terracotta su vetro	0,30

Classificazione dell'opera

Classificazione dell'opera in base alla tipologia

T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	□	Statue, sculture e grandi vasi
T4	□	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	√	Altro

Classificazione dell'opera in base alla tipologia del supporto

	A				B	C		D
	Oggetti poggiati su una superficie piana				Oggetti fissati su un piedistallo	Oggetti appesi o sospesi		Altro
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	su mensole o all'interno di bacheche		appesi ad una parete	sospesi al soffitto	
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	-	*	-	-	-
T4	-	-	-	-	-	*	-	*
T5	-	-	-	-	-	-	*	-
T6	√	*	*	*	*	*	*	*

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte

Categoria	Modalità di risposta		Meccanismi di danno		Sigla
A	moto attaccato	√	sollecitazioni eccessive	√	R1
	scivolamento	□	spostamenti eccessivi	□	R2
	oscillazioni	□	urti ripetuti	□	R3
	oscillazioni	□	ribaltamento	□	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	√	sollecitazioni eccessive	√	R1
	moto attaccato	□	spostamenti eccessivi	□	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	√	Discreto	□	Scadente	□	Pessimo	□
STATO DI CONSERVAZIONE DELL'OPERA							
SCULTURE, ALTORILIEVI, BASSORILIEVI IN LEGNO							
SUPPORTO		Aggressione da insetti	□	Deformazione	□	Mancanze (mutilazioni)	□
		Bruciature	□	Marcescenza	□	Macchie di umidità	□
		Altro					□
PELLICOLA PITTORICA		Caduta di colore	□	Distacco	□	Decoesione	□
		Polverizzazione	□	Depositi superficiali	□	Tracce di bruciature	□
		Lacune	□	Efflorescenza	□	Integrazioni	□
		Altro					□

Figure A.26. Painting; *Gesù moltiplica i pani e i pesci*

Table A.30. Sheet "Gesù moltiplica i pani e i pesci": Identification of the artwork

Identification of the artwork						
Object	Painting					
Subject	Gesù moltiplica i pani e i pesci					
Author	Francesco Caccianiga (?)					
Cultural Context						
Chronology	year 1769		century		era	
Position	Church	□	Museum room	□	Palace	√
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	□	Wall sx	□	Lunette dx	□
	Lunette sx	□	Vault	□	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	√

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	420				610			
Tipologia	Amovibile			√	Inamovibile			□
	Opera isolata			□	Serie			□
	Frammento			□	Altro			□
	Note							
Precedenti restauri	Interventi documentati			□	Interventi non documentati			□
	Note							
	Rifacimenti/Aggiunte							
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	□	Cavi eletti	□
	Note							

CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC
	Affreschi	□			Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	√		
	Arazzi	□			Arredi	□		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		

MATERIALI						
STRUTTURE DI SOSTEGNO	Fisse	√	Mobili	□	Sospese	□
	Vetrina	□	Cavalletto	□	Mensola	□
	Bacheca	□	Piedistallo	□	Soffitto	□
	Parete	√	Pavimento	□	Pannello	□
	Scaffalatura	□	Rastrelliera	□	Altro	□
	Note					
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	□	Telaio	√	Chiodi	√
	Corde o fili metallici	√	Base murale	□	Parchettature	□
	Altro					□
SUPPORTO	Tela	√	Legno	□	Metallo	□
	Vetro	□	Carta	□	Pietra	□
	Cuoio	□	Pergamena	□	Intonaco - Muratura	□

Misure del supporto [cm]	Altezza [H]	Profondità [P]	Larghezza [L]	Diametro [D]

STRUTTURE AUSILIARIE SUPPORTO						
	Cornice	Solidale al supporto o parte integrante di esso		√	SI □	NO □
		Vincolata rigidamente		□	SI □	NO □
		Ligena	□	Metallica		□
		Gesso	√	Listello		□
		Modanata	√	Dorata		□
		Dipinta	□	Intagliata		□
		Intarsiata	□	Altro		□
	Telaio	Ligneo	√	Rigido		□
		Metallico	□	Scomponibile		□
		Mobile	□	Altro		□
STRATI PREPARATORI	Gesso	□	Intonaco	□	Colla	□
PELLICOLA PITTORICA	Dipinti a olio	√	Dipinti a tempera	□	Acquerelli	□

Coefficiente d'attrito - Superficie materiali					
Alluminio su formica	0,12	Teflon su mosaico	0,10	Plexiglass su vetro	0,20
Marmo su formica	0,18	Alluminio su legno	0,37	Plexiglass su teflon	0,15
Teflon su formica	0,13	Alluminio su alluminio	0,24	Teflon su vetro	0,13
Alluminio su mosaico	0,20	Alluminio su teflon	0,23	Terracotta su plexiglass	0,30
Marmo su mosaico	0,13	Plexiglass su plexiglass	0,35	Terracotta su vetro	0,30

Classificazione dell'opera								
Classificazione dell'opera in base alla tipologia								
T1	□	Piccoli oggetti a base piana						
T2	□	Piccoli oggetti privi di base piana						
T3	□	Statue, sculture e grandi vasi						
T4	√	Quadri e dipinti						
T5	□	Lampadari ed oggetti sospesi						
T6	□	Altro						

Classificazione dell'opera in base alla tipologia di sostegno								
	A				**B**	**C**		**D**
	Oggetti poggiati su una superficie piana				Oggetti fissati su un piedistallo	Oggetti appesi o sospesi		Altro
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	mensole o all'interno di		appesi ad una parete	sospesi al soffitto	
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	-	*	-	-	-
T4	-	-	-	-	-	*	-	√
T5	-	-	-	-	-	-	*	-
T6	*	*	*	*	*	*	*	*

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte				
Categoria	**Modalità di risposta**		**Meccanismi di danno**	**Sigla**
A	moto attaccato	□	sollecitazioni eccessive □	R1
	scivolamento	□	spostamenti eccessivi □	R2
	oscillazioni	□	urti ripetuti □	R3
	oscillazioni	□	ribaltamento □	R4
B	moto attaccato	□	sollecitazioni eccessive □	R1
C	oscillazioni	□	spostamenti eccessivi □	R5
				R6
D	moto attaccato	□	sollecitazioni eccessive □	R1
	moto attaccato	√	spostamenti eccessivi √	R2
	moto attaccato	□	scorrimento □	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	√	Discreto	□	Scadente	□	Pessimo	□

STATO DI CONSERVAZIONE DELL'OPERA							
DIPINTI SU TELA							
TELAIO LIGNEO	Aggressione da insetti	□	Sali di rame	□	Alterazione cromatica	□	
	Marcescenza	□	Macchie di ruggine	□	Carie	□	
	Note: telaio non visibile					√	
SUPPORTO	Lacerazioni	□	Strappi	□	Rilassamento	□	
	Aggressione da insetti	□	Bruciature	□	Macchie di umidità	□	
PELLICOLA PITTORICA	Distacco	□	Decoesione	□	Patina biologica	□	
	Polverizzazione	□	Macchie di umidità	□	Tracce di bruciature	□	
	Caduta di colore	□	Efflorescenza salina	□	Lacune	□	
	Altro					□	

Figure A.27. Oval-shaped Painting; *I beati Laudavino e Guglielmo*

Table A.31. Sheet "I beati Laudavino e Guglielmo": Identification of the artwork

Identification of the artwork						
Object	Oval-shaped Painting					
Subject	I beati Laudavino e Guglielmo					
Author	Filippo Balbi					
Cultural Context						
Chronology	year 1863 circa		century		era	
Position	Church	□	Museum room	□	Palace	√
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	√	Wall sx	□	Lunette dx	□
	Lunette sx	□	Vault	□	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	□

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	200				140			
Tipologia	Amovibile			√	Inamovibile			□
	Opera isolata			□	Serie			√
	Frammento			□	Altro			□
	Note							
Precedenti restauri	Interventi documentati			□	Interventi non documentati			□
	Note							
	Rifacimenti/Aggiunte							
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	□	Cavi elettric	□
	Note							
CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC.
	Affreschi	□			Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	√		
	Arazzi	□			Arredi	□		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		
MATERIALI								
STRUTTURE DI SOSTEGNO	Fisse	√	Mobili	□	Sospese	□		
	Vetrina	□	Cavalletto	□	Mensola	□		
	Bacheca	□	Piedistallo	□	Soffitto	□		
	Parete	√	Pavimento	□	Pannello	□		
	Scaffalatura	□	Rastrelliera	□	Altro	□		
	Note							
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	□	Telaio	√	Chiodi	√		
	Corde o fili metallici	□	Base murale	□	Parchettature	□		
	Altro						□	
SUPPORTO	Tela	√	Legno	□	Metallo	□		
	Vetro	□	Carta	□	Pietra	□		
	Cuoio	□	Pergamena	□	Intonaco/Muratura	□		
Misure del supporto [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
STRATI PREPARATORI	Gesso	□	Intonaco	□	Colla	□		
PELLICOLA PITTORICA	Dipinti a olio	√	Dipinti a tempera	□	Acquerelli	□		

Coefficiente d'attrito - Superficie materiali					
Alluminio su formica	0,12	Teflon su mosaico	0,10	Plexiglass su vetro	0,20
Marmo su formica	0,18	Alluminio su legno	0,37	Plexiglass su teflon	0,15
Teflon su formica	0,13	Alluminio su alluminio	0,24	Teflon su vetro	0,13
Alluminio su mosaico	0,20	Alluminio su teflon	0,23	Terracotta su plexiglass	0,30
Marmo su mosaico	0,13	Plexiglass su plexiglass	0,35	Terracotta su vetro	0,30

Classificazione dell'opera		
Classificazione dell'opera in base alla tipologia		
T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	□	Statue, sculture e grandi vasi
T4	√	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	□	Altro

Classificazione dell'opera in base alla tipologia di sostegno

	A				B	C		D
	Oggetti poggiati su una superficie piana				Oggetti fissati su un piedistallo	Oggetti appesi o sospesi		Altro
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	su mensole o all'interno di bacheche		appesi ad una parete	sospesi al soffitto	
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	-	*	-	-	-
T4	-	-	-	-	-	√	-	*
T5	-	-	-	-	-	-	*	-
T6	*	*	*	*	*	*	*	*

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte

Categoria	Modalità di risposta		Meccanismi di danno		Sigla
A	moto attaccato	□	sollecitazioni eccessive	□	R1
	scivolamento	□	spostamenti eccessivi	□	R2
	oscillazioni	□	urti ripetuti	□	R3
	oscillazioni	□	ribaltamento	□	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	oscillazioni	√	spostamenti eccessivi	√	R5
					R6
D	moto attaccato	□	sollecitazioni eccessive	□	R1
	moto attaccato	□	spostamenti eccessivi	□	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	□	Discreto	□	Scadente	√	Pessimo	□

STATO DI CONSERVAZIONE DELL'OPERA							
DIPINTI SU TELA							
TELAIO LIGNEO	Aggressione da insetti	□	Sali di rame	□	Alterazione cromatica	√	
	Marcescenza	√	Macchie di ruggine	□	Carie	□	
	Altro					□	
SUPPORTO	Lacerazioni	□	Strappi	□	Rilassamento	□	
	Aggressione da insetti	□	Bruciature	□	Macchie di umidità	□	
PELLICOLA PITTORICA	Distacco	□	Decoesione	□	Patina biologica	□	
	Polverizzazione	□	Macchie	√	Tracce di bruciature	□	
	Caduta di colore	√	Efflorescenza salina	□	Lacune	□	
	Altro					√	

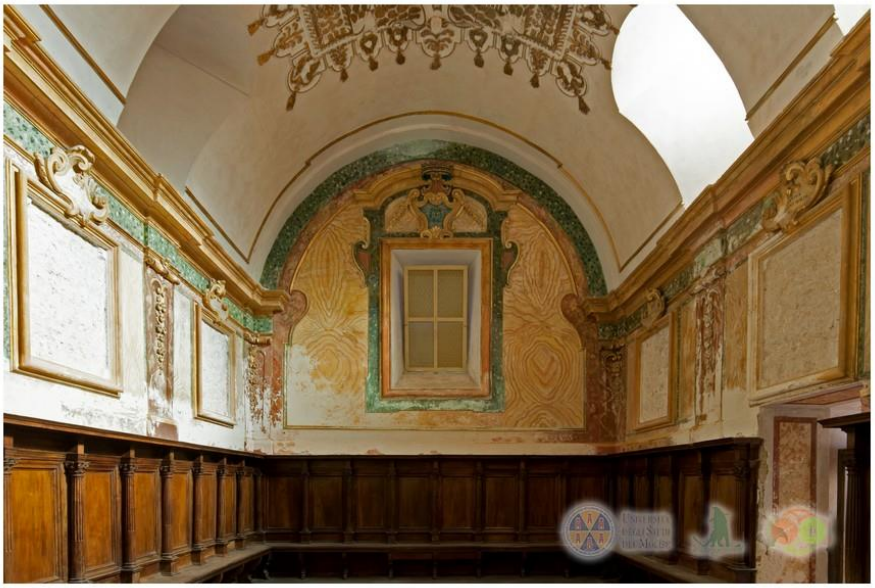


Figure A.28. Chapter House; Backrest in walnut with fixed seats

Table A.32. Sheet "Chapter House; Backrest in walnut with fixed seats": Identification of the artwork

Identification of the artwork						
Object	Backrest in walnut with 30 fixed seats					
Subject						
Author	Domenico Busseto					
Cultural Context						
Chronology	year 1639-1640		century		era	
Position	Church	□	Museum room	□	Palace	√
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	□	Wall sx	□	Lunette dx	□
	Lunette sx	□	Vault	□	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	□
	Showcase	□	Display case	□	Other	√

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	90		73		77			
Tipologia	Amovibile			□	Inamovibile			√
	Opera isolata			□	Serie			□
	Frammento			□	Altro			□
	Note							
Precedenti restauri	Interventi documentati			□	Interventi non documentati			□
	Note							
	Rifacimenti/Aggiunte							
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	□	Cavi elettric	□
	Note							

CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC.
	Affreschi	□			Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	□		
	Arazzi	□			Arredi	√		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		

MATERIALI								
STRUTTURE DI SOSTEGNO	Fisse	√	Mobili	□	Sospese	□		
	Vetrina	□	Cavalletto	□	Mensola	□		
	Bacheca	□	Piedistallo	□	Soffitto	□		
	Parete	√	Pavimento	√	Pannello	□		
	Scaffalatura	□	Rastrelliera	□	Altro	□		
	Note							
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	□	Telaio	√	Chiodi	√		
	Corde o fili metallici	□	Base murale	□	Parchettature	□		
	Altro					□		
SUPPORTO	Tela	□	Legno	√	Metallo	□		
	Vetro	□	Carta	□	Pietra	□		
	Cuoio	□	Pergamena	□	Intonaco/Muratura	□		
Misure del supporto [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	231		73		754			

Coefficiente d'attrito - Superficie materiali					
Alluminio su formica	0,12	Teflon su mosaico	0,10	Plexiglass su vetro	0,20
Marmo su formica	0,18	Alluminio su legno	0,37	Plexiglass su teflon	0,15
Teflon su formica	0,13	Alluminio su alluminio	0,24	Teflon su vetro	0,13
Alluminio su mosaico	0,20	Alluminio su teflon	0,23	Terracotta su plexiglass	0,30
Marmo su mosaico	0,13	Plexiglass su plexiglass	0,35	Terracotta su vetro	0,30

Classificazione dell'opera		
Classificazione dell'opera in base alla tipologia		
T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	□	Statue, sculture e grandi vasi
T4	□	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	√	Altro

Classificazione dell'opera in base alla tipologia del supporto

	A				B	C		D
	Oggetti poggiati su una superficie piana				Oggetti fissati su un piedistallo	Oggetti appesi o sospesi		Altro
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	su mensole o all'interno di bacheche		appesi ad una parete	sospesi al soffitto	
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	-	*	-	-	-
T4	-	-	-	-	-	*	-	*
T5	-	-	-	-	-	-	*	-
T6	√	*	*	*	*	*	*	*

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte

Categoria	Modalità di risposta		Meccanismi di danno		Sigla
A	moto attaccato	□	sollecitazioni eccessive	□	R1
	scivolamento	□	spostamenti eccessivi	□	R2
	oscillazioni	□	urti ripetuti	□	R3
	oscillazioni	□	ribaltamento	□	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	□	sollecitazioni eccessive	□	R1
	moto attaccato	√	spostamenti eccessivi	√	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	□	Discreto	√	Scadente	□	Pessimo	□
STATO DI CONSERVAZIONE DELL'OPERA							
SCULTURE, ALTORILIEVI, BASSORILIEVI IN LEGNO							
SUPPORTO		Aggressione da insetti	□	Deformazione	□	Mancanze (mutilazioni)	□
		Bruciature	□	Marcescenza	□	Macchie di umidità	□
		Altro					□
PELLICOLA PITTORICA		Caduta di colore	□	Distacco	□	Decoesione	□
		Polverizzazione	□	Depositi superficiali	□	Tracce di bruciature	□
		Lacune	□	Efflorescenza	□	Integrazioni	□
		Altro					□

Figure A.29. Chapter House; *Maddalena Penitente nella grotta di Marsiglia*

Table A.33. Sheet "Maddalena Penitente nella grotta di Marsiglia": Identification of the artwork

Identification of the artwork						
Object	Painting					
Subject	Maddalena Penitente nella grotta di Marsiglia					
Author	Giacomo Manco					
Cultural Context						
Chronology	year 1788-1790		century		era	
Position	Church	□	Museum room	□	Palace	√
	Outdoor spaces	□	Street/Square	□	Archaeological site	□
Specific Location	Wall dx	□	Wall sx	□	Lunette dx	□
	Lunette sx	□	Vault	□	Dome	□
	Side Chapel dx	□	Side chapel sx	□	Altar	√
	Showcase	□	Display case	□	Other	□

Dati dimensionali e tipologici								
Misure [cm]	**Altezza [H]**		**Profondità [P]**		**Larghezza [L]**		**Diametro [D]**	
	230				170			
Tipologia	Amovibile			√	Inamovibile			□
	Opera isolata			□	Serie			□
	Frammento			□	Altro			□
	Note							
Precedenti restauri	Interventi documentati			□	Interventi non documentati			□
	Note							
	Rifacimenti/Aggiunte							
	Fori	□	Chiodi	□	Viti	□	Grappe	□
	Staffe	□	Schizzi	□	Stuccature	□	Cavi eletti	□
	Note							
CLASSIFICAZIONE TIPOLOGICA BENI ARTISTICI								
TIPOLOGIA	TIPOLOGIA		NUM.	SUPERFIC.	TIPOLOGIA		NUM.	SUPERFIC
	Affreschi	□			Altari/Statue	□		
	Mosaici	□			Libri/Stampe	□		
	Stucchi	□			Dipinti mobili	√		
	Arazzi	□			Arredi	□		
	Decorazioni plastiche	□			Manufatti in carta	□		
	Reperti archeologici	□			Altro	□		
MATERIALI								
STRUTTURE DI SOSTEGNO	Fisse	□	Mobili		□	Sospese	□	
	Vetrina	□	Cavalletto		□	Mensola	□	
	Bacheca	□	Piedistallo		□	Soffitto	□	
	Parete	□	Pavimento		□	Pannello	□	
	Scaffalatura	□	Rastrelliera		□	Altro	√	
	Note: la tela non si trova nella sua collocazione originaria ma è stata posta e appoggiata all'altare							
STRUTTURE AUSILIARIE DI SOSTEGNO	Staffe	□	Telaio		√	Chiodi	√	
	Corde o fili metallici	□	Base murale		□	Parchettature	□	
	Altro						√	
SUPPORTO	Tela	√	Legno		□	Metallo	□	
	Vetro	□	Carta		□	Pietra	□	
	Cuoio	□	Pergamena		□	Intonaco - Muratura	□	
STRUTTURE AUSILIARIE SUPPORTO	**Telaio**	Ligneo	√		Rigido		□	
		Metallico	□		Scomponibile		□	
		Mobile	□		Altro		□	
STRATI PREPARATORI	Gesso	□	Intonaco		□	Colla	□	
PELLICOLA PITTORICA	Dipinti a olio	√	Dipinti a tempera		□	Acquerelli	□	
Coefficiente d'attrito - Superficie materiali								
Alluminio su formica	0,12	Teflon su mosaico		0,10	Plexiglass su vetro		0,20	
Marmo su formica	0,18	Alluminio su legno		0,37	Plexiglass su teflon		0,15	
Teflon su formica	0,13	Alluminio su alluminio		0,24	Teflon su vetro		0,13	
Alluminio su mosaico	0,20	Alluminio su teflon		0,23	Terracotta su plexiglass		0,30	
Marmo su mosaico	0,13	Plexiglass su plexiglass		0,35	Terracotta su vetro		0,30	

Classificazione dell'opera		
Classificazione dell'opera in base alla tipologia		
T1	□	Piccoli oggetti a base piana
T2	□	Piccoli oggetti privi di base piana
T3	□	Statue, sculture e grandi vasi
T4	√	Quadri e dipinti
T5	□	Lampadari ed oggetti sospesi
T6	□	Altro

Classificazione dell'opera in base alla tipologia di sostegno

	A				B	C		D
	Oggetti poggiati su una superficie piana				Oggetti fissati su un piedistallo	Oggetti appesi o sospesi		Altro
	A1	A2	A3	A4		C2	C2	
	sul pavimento	su di un piedistallo	all'interno di vetrine	mensole o all'interno di		appesi ad una parete	sospesi al soffitto	
T1	*	*	*	*	*	-	-	-
T2	*	*	*	*	*	-	-	-
T3	*	*	-	-	*	-	-	-
T4	√	-	-	-	-	*	-	*
T5	-	-	-	-	-	-	*	-
T6	*	*	*	*	*	*	*	*

Meccanismi di risposta dinamica e di danno delle diverse categorie di oggetti d'arte

Categoria	Modalità di risposta		Meccanismi di danno		Sigla
A	moto attaccato	□	sollecitazioni eccessive	□	R1
	scivolamento	□	spostamenti eccessivi	□	R2
	oscillazioni	□	urti ripetuti	□	R3
	oscillazioni	√	ribaltamento	√	R4
B	moto attaccato	□	sollecitazioni eccessive	□	R1
C	oscillazioni	□	spostamenti eccessivi	□	R5
					R6
D	moto attaccato	□	sollecitazioni eccessive	□	R1
	moto attaccato	√	spostamenti eccessivi	√	R2
	moto attaccato	□	scorrimento	□	R7

STATO DI CONSERVAZIONE GENERALE DELL'OPERA							
Buono	√	Discreto	□	Scadente	□	Pessimo	□

STATO DI CONSERVAZIONE DELL'OPERA						
DIPINTI SU TELA						
TELAIO LIGNEO	Aggressione da insetti	□	Sali di rame	□	Alterazione cromatica	□
	Marcescenza	□	Macchie di ruggine	□	Carie	□
	Note: telaio non visibile					√
SUPPORTO	Lacerazioni	□	Strappi	□	Rilassamento	□
	Aggressione da insetti	□	Bruciature	□	Macchie di umidità	□
PELLICOLA PITTORICA	Distacco	□	Decoesione	□	Patina biologica	□
	Polverizzazione	□	Macchie di umidità	□	Tracce di bruciature	□
	Caduta di colore	□	Efflorescenza salina	□	Lacune	□
	Altro					□

References

[1] D. d. r. Dipartimento della Protezione Civile, "<http://www.protezionecivile.gov.it>," 2012. [Online].

[2] A. Baratta, T. Colletta and G. Zuccaro, Seismic risk of historic centres. A preliminary approach to the Naples' case, Napoli: La citta' del Sole, 1996, p. Capitolo 1.

[3] S. Cafiso, A. D'Andrea and A. Condorelli, "Evaluation Of Seismic Risk on Road Infrastructures," in *PIARC XXI World Road Congress*, Kuala Lumpur, 1999.

[4] C. G.N.D.T., "Rischio Sismico di Edifici Pubblici," Bologna, 1993.

[5] Decreto legislativo 22 gennaio 2004, n. 42, *Codice dei beni culturali e del paesaggio, ai sensi dell'articolo 10 della legge 6 luglio 2002, n. 137,* GU n.45 del 24-2-2004 - Suppl. Ordinario n. 28.

[6] A. Aveta, Conservazione e valorizzazione del patrimonio culturale. Indirizzi e norme per il restauro architettonico, Napoli: Arte Tipografica Editrice, 2005.

[7] B. G. Marino, "Note sulla definizione dell'oggetto di tutela nelle Carte del Restauro," in *Conservazione e valorizzazione del patrimonio culturale. Indirizzi e norme per il restauro architettonico.*, Napoli, Arte Tipografica Editrice, 2005.

[8] Ministero per i Beni e le Attività Culturali, *Atti di indirizzo sui criteri tecnico-scientifci e sugli standard di funzionamento e sviluppo dei musei.*

[9] T. Alibrandi and P. Ferri, I beni culturali e ambientali, Milano, 1985.

[10] I. C. o. M. ICOM, "http: / / icom.museum," [Online].

[11] I. C. o. M. ICOM, "http: / /www.icom-italia.org," [Online].

[12] G. Rolla, "Museo come servizio pubblico locale. Disciplina giuridica e profili organizzativi," 2004. [Online].

[13] D.M. 10 maggio 2001, *Atto di indirizzo sui criteri tecnico- scientifici e sugli standard di funzionamento e sviluppo dei musei (Art. 150, comma 6, del D.Lgs.n.112/98),* G.U. 19 ottobre 2001, n.244, S.O..

[14] L. Zevi, Il nuovissimo manuale dell'architetto, L. Zevi, Ed., Mancosu Editore, 2004.

[15] La Cartografia Tematica, Carta del Rischio del Patrimonio culturale, vol. Vol.1 – A.T.I Mar, A. S. e. A. Ministero per i Beni Culturali ed Ambientali – Ufficio Centrale per i Beni Archeologici, Ed., Istituro Centrale per il Restauro, 1996.

[16] F. Lipfert, Atmospheric damage to calcareous stones: comparison and reconciliation of recent experimental finding, 1989.

[17] ISPRA, Calcolo del rischio territoriale e del rischio individuale per i beni di interesse storico-artistico a Torino, P. Bonanni, C. Cacace, R. Gaddi and A. Giovagnoli, Eds., Roma, 2009.

[18] "Analisi multi-hazard per la valutazione del rischio locale dei beni culturali. Atti 12° Conferenza Nazionale ASITA – l'Aquila," in *Conferenza Nazionale ASITA*, L'Aquila, 21-24 ottobre 2008.

[19] D. De Vivo, *Il rapporto catalogazione/conservazione nella tutela dei beni architettonici e ambientali.*

[20] A. Emiliani, Leggi, bandi e provvedimenti per la tutela dei Beni Artistici e Culturali negli antichi stati italiani 1571-1860, Bologna: Nuova Alfa, 1996, p. 121.

[21] F. Negri Arnoldi, Il catalogo dei beni culturali e ambientali, Roma: La Nuova Italia, 1981.

[22] V. Curzi, Bene culturale e pubblica utilità. Politiche di tutela a Roma tra Ancien Régime e Restaurazione, Bologna, 2004.

[23] M. Bencivenni, R. Dalla Negra and P. Grifoni, Monumenti e Istituzioni. Parte I (1860-80); Parte II (1880-1915), Firenze: Alinea, 1987.

[24] G. Fiorelli, "Sui Restauri degli Edifici Monumentali, circolare del 21 luglio 1882 (n.683 bis)," in *Monumenti e Istituzioni. Parte II (1880-1915)*, Firenze, Alinea, 1987, pp. 49-50.

[25] ISCR, "http://www.icr.beniculturali.it/," [Online].

[26] L.G., Direttiva P.C.M. 12 ottobre 2007 per la valutazione e riduzione del rischio sismico del patrimonio culturale tutelato, S.O. n. 25 alla G.U. n. 24 del 29 gennaio 2008, update 9 febbraio 2011, (GU n. 47 del 26.02.11)., 2011.

[27] R. Di Stefano, Il consolidamento strutturale nel restauro architettonico, Napoli: Edizioni Scientifiche Italiane, 1990.

[28] E. E. Viollet-le-Duc, Dictionnaire raisonné de l'architecture française du Xi siècle, vol. VIII, Parigi, 1854-1868.

[29] S. Pesenti, "Il progetto di conservazione come progetto di conoscenza e di gestione della trasformazione: l'iter processuale," in *Il progetto di conservazione: linee metodologiche per le analisi preliminari, l'intervento, il controllo di efficacia*, Alinea Editrice, 2002.

[30] M. Ciampoli and G. Augusti, Vulnerabilità dei beni archeologici e degli oggetti esibiti nei musei, D. Liberatore, Ed., Roma: CNR-Gruppo Nazionale per la Difesa dai Terremoti, 2000.

[31] M. S. Agbabian, S. F. Masri and R. L. Nigbor, Evaluation of seismic mitigation measures for art objects, The Getty Conservation Institute, Marina del Rey, CA ed., Dept. Civil Engrg., Univ. of Southern California, Los Angeles, 1990.

[32] N. Abbas, C. Calderini, S. Cattari, S. Lagomarsino, M. Rossi, R. Ginnani Corradini, G. Marghella and V. Piovanello, "Classification of the cultural heritage assets, description of the target performance and identification of damage measures," 2010.

[33] S. Mastrodicasa, Dissesti statici delle strutture murarie, Hoelpi Editore, 1999.

[34] R. Antonucci, Restauro e recupero degli edifici a struttura muraria. Analisi e interventi sul costruito storico, Maggioli Editore, 2003.

[35] CNR–GNDT , "Rilevamento dell'esposizione e vulnerabilità sismica degli edifici: istruzioni per la compilazione della scheda di I livello. Appendice n. 1 alla pubblicazione "Rischio sismico di edifici pubblici" – Parte I – Aspetti metodologici," Roma, 1993.

[36] SSN–GNDT, Manuale per la compilazione della scheda di 1° livello di rilevamento danno, pronto intervento e agibilità per edifici ordinari nell'emergenza post-sismica (AeDES)., Roma: Presidenza del Consiglio dei Ministri - Dipartimento della Protezione Civile, 2009.

[37] NTC, *Norme Tecniche per le Costruzioni,* Roma: G.U. n. 29 del 4 febbraio 2008, 2008.

[38] CNR-GNDT, "Rilevamento della vulnerabilità sismica degli edifici in muratura: istruzioni per la compilazione della scheda di II livello. Appendice n. 2 alla pubblicazione "Rischio sismico di edifici pubblici" – Parte I – Aspetti metodologici," Roma, 1993.

[39] L. Binda, "Scheda Muratura del Gruppo Nazionale per la Difesa dai Terremoti; Regione Molise," 2005.

[40] C. Pasquale and A. Lemme, *Edifici in muratura. Indicazioni per la valutazione della qualità delle murature. Allegato 3D, Regione Molise,* 2003.

[41] ICCD/Istituto CNUCE, *Strutturazione dei dati delle schede di catalogo - Beni mobili archeologici e storico-artistici,* ICCD & Istituto CNUCE, 1992.

[42] G. Augusti, M. Ciampoli and L. Airoldi, "Protezione sismica degli oggetti d'arte: uno studio preliminare," *Ingegneria Sismica,* vol. I, no. 10, 1993.

[43] G. Augusti and M. Ciampoli, "Guidelines for seismic protection of museum contents," in *11 WCEE- 11th World conference on Earthquake Engineering*, Acapulco, Messico.

[44] "http://www.artiumbria.beniculturali.it/," [Online].

[45] “http://www.artiumbria.beniculturali.it/,” [Online].

[46] “http://www.artiumbria.beniculturali.it/,” [Online].

[47] L. Binda and A. Saisi, “Il ruolo delle indagini nella diagnostica strutturale”.

[48] D. Fiorani, Tecniche costruttive murarie medievali. Il Lazio meridionale - Storia della tecnica edilizia e restauro dei monumenti, L'Erma di Bretschneider, 1996.