CULTURAL HERITAGE
A CHALLENGE FOR EUROPE

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Changes in Cultural Heritage Activities: New Goals and Benefits for Economy and Society

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CHANGES is a European Project supported by the JPI Heritage Plus program.

Considering the diversity of European cultural heritage, the skills required in built heritage activities and the spread of environmentally sustainable approaches, the research aims at

producing new local models directed to support
Planned Preventive Conservation, Maintenance and Monitoring.

The **main topics** are:

- conservation and valorisation as preventive measures;
- effectiveness of maintenance, involving relevant craftsmanship and expertise;
- economic mechanisms underlying built heritage conservation in the context of regional economy and the wider construction sector;
- impact of knowledge gain and its dissemination on smart economy for built heritage conservation, heritage management and construction sector.

The **expected outcomes**, to be transferred to stakeholders and society, in order to increase social and human capital at a local level are:

- a better understanding of cultural heritage;
- an empowerment of local communities;
- a progress of protection quality of built heritage;
- environmental enhancement;
- an improved cost-effectiveness for private owners and managers of historic properties;
- a proposal for a funding scheme supporting a sustainable conservation process.

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Changes in Cultural Heritage Activities: New Goals and Benefits for Economy and Society

Partners:

- **Politecnico di Milano**, ABC Department
- **Katholieke Universiteit Leuven**, MAT Division
- **Uppsala University**
- **Delft Universtity of Technology**, Heritage & Architecture Section
- **Foppoli Moretta e Associati**

Associate Partners:

- Monumentenwacht Noord-Brabant
- Monumentenwacht Flanders
- Consorzio Villa Reale e Parco di Monza
- Navarra Gestioni
- Assimpredil ANCE, Association of Building and Related Companies of Milano, Lodi, Monza e Brianza provinces

Work Packages:

1. Project Management.
2. Conceptualization of previous experiences: **MonumentenWacht** in Belgium and in the Netherlands, **Halland Model** in Sweden, **Distretti Culturali** in Italy.
3. Implementation of maintenance systems: investigation on efficacy of maintenance practices in Belgium.
4. Implementation of maintenance systems: investigation on efficacy of maintenance practices in The Netherlands.
5. Implementation of maintenance systems: investigation on efficacy of maintenance practices in Italy.
6. Economic analysis of costs and benefits of preventive conservation practices (monitoring and maintenance systems).
7. Analysis of economic and societal impacts and externalities of valorisation strategies including conservation activities.
8. Dissemination and transfer.

WP5
IMPLEMENTATION OF MAINTENANCE SYSTEMS:
INVESTIGATION ON EFFICACY OF MAINTENANCE PRACTICES IN ITALY

Responsible
Principal Investigator 1: Prof. Stefano Della Torre, Politecnico di Milano, Department of Architecture, Built Environment and Construction Engineering.

Partners involved
- **Principal Investigator 1**: Prof. Stefano Della Torre, Politecnico di Milano, Department of Architecture, Built Environment and Construction Engineering.
- **Principal Investigator 5**: Engineer Dario Foppoli, Foppoli Moretta e Associati consulting engineers.
- **Associate partner**: Consortium Royal Villa and Park of Monza
- **Associate partner**: Navarra Gestioni (Na.Gest)
- **Associate partner**: Assimpredil ANCE

Methodology adopted
Action Research.

Timing
November 2015 – October 2017

Abstract
Thanks to Associate Partners, Principal Investigator 1 was able to implement research on a very important case study, the Royal Villa in Monza, where a huge conservation and valorisation project is ongoing and good maintenance practices are being executed.
Besides the Royal Villa, other case studies were available in the area, already involved in the Cultural District project, a wide area program mixing heritage and creativity for a local development strategy. They enriched the sample with data referred to properties where management systems were adopted and stakeholders had experiences with these issues.
The case studies provided opportunities to test:
- Costs of post-intervention maintenance systems integrated into the facility management.
- The role of conservation activities in the framework of valorisation strategies.
- The relationships between the pilot projects and the surrounding cultural system, by the involvement of public, professionals, grassroots organisations, etc.

Activities on the field involved the Principal Investigator 1 (Prof. Stefano Della Torre and the staff of the Department of Architecture, Built Environment and Construction Engineering of the Politecnico di Milano) and the Principal Investigator 5 (Foppoli Moretta e associati consulting engineers), besides the operators on behalf of Associate Partners.
Data were gathered by:
- Condition assessment of the building, that means focused on the physical state of conservation.
- Checking expenses made and estimating suggested maintenance works.
- Meetings with stakeholders on awareness, social benefits, boundary conditions.

Link to other WPs
Gathered information were processed both in WP6 and WP7.

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INTRODUCTION

Partners involved

The Italian case studies encompassed representatives of different stakeholders as associate partners: public authorities, entrepreneurs in the management of cultural activities and an organisation of building entrepreneurs. This aspect gave rich inputs to the action-research and contributed in the transfer of the project outcomes directly to the end-users.

Activities developed within WP5 involved:

- **Principal Investigator 1 – ABC Department, Politecnico di Milano**.
- **Principal Investigator 5 – Foppoli Moretta e Associati consulting engineers**.
- **Associate partner – Consortium Royal Villa and Park of Monza**: it has been established in 2009 with the aim of conserving and valorising the Reggia of Monza, including the Royal Villa and the Park. It includes the State (Ministry of Cultural Heritage and Activities and Tourism), Lombardy Region, Municipality of Monza, Municipality of Milan, Province of Monza and Brianza and the Confindustria Monza and Brianza. The planned conservation is clearly declared as one of the reasons of the Consortium. The Royal Villa and its park are at the heart of the Monza and Brianza Cultural District and are part of the case studies analyzed in WP5.
- **Associate partner – Navarra Gestioni (Na.Gest)**: it is the private company in charge for the management of the part of the Royal Villa which was recently restored through a concession initiative. In fact, this private subject partly financed the restoration works and is managing the property for the following 22 years, assuming the responsibility for its conservation and valorisation. The scheme is interesting for the research perspective as it entails the coordination between the private entity (tenant) and the public entities (owners). Moreover, the example shows the follow-up of a restored property where the manager is the same subject who executed the works: it is obliged to give back the property in a perfect state of conservation after using it for a quite long period.
- **Associate partner – Assimpredil ANCE**: it is the Association of Building and Related Companies of the Provinces of Milano, Lodi, Monza and Brianza. It represents the construction industry and its point of view on the ongoing transitions. This association pays a strong attention to the sector of heritage conservation and enhancement, as also demonstrated with the organization of events directed at presenting restoration works to the public (http://www.milanoneicantieridellarte.it).

General description of the activities

This phase represented the first step for the development of the following WPs.

The implementation of maintenance systems and the investigation on efficacies of maintenance practices in Italy were twofold:

- On the one hand the data collection referred to the buildings' physical conditions and to the conservation quality assessment was elaborated.
- On the other hand the activities tried to detect the attitudes of the stakeholders involved in the process. In fact, one of the objectives was to assess built heritage maintenance interventions in terms of effectiveness (quality), relevant craftsmanship and expertise (knowledge).

In Italy the activities on the field were finalized to:

- Investigate the role of conservation activities in the framework of valorisation strategies.
- Test cost/efficiency of a post-intervention maintenance system integrated into the facility management.
- Study the relationship between the case studies and the surrounding cultural system, constituted of public and private owners, practitioners, enterprises, grass-root organisations, etc.

The following data were gathered, in order to be processed in WP6 and WP7:

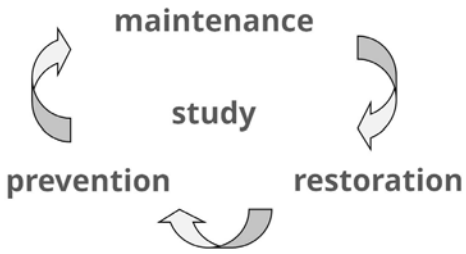
- Condition assessment of the buildings identified, focusing on their state of conservation.
- Verification of expenses and estimation of suggested maintenance works.

- Interviews and focus groups directed at examining awareness, social benefits and boundary conditions.

This work package also represented the opportunity to reflect on the information system adopted in the Italian context, i.e. Planet Beni Architettonici, in relation to the information systems adopted by the other partners (MAKSbo in Monumentenwacht Flanderen model and MDDS in Holland research).

Preventive and Planned Conservation (PPC) in the Italian context

The Art. 29 of the Italian Cultural Heritage and Landscape Code states that "The conservation of the cultural heritage is ensured by means of a consistent, coordinated and programmed activity of study, prevention, maintenance and restoration". Each phase is part of a circular process, that can be implemented across the time.



Representation of the circular process of the conservation in the Italian context (Legislative Decree 42/2004, art. 29).

During the last 15 years Italian research worked for a step from restoration as an event to conservation meant as a process, which entails actions coordinated and scheduled over time. According to this vision a strategy for Preventive and Planned Conservation (PPC) was developed and the operational tool of the conservation plan was designed. In 2003 the Lombardy Region published the "Guidelines for the Conservation Plan and the scientific final balance", officially issued in 2005, which define contents and methodology to be implemented in the compilation of the document (Della Torre, 2003).
All the activities entailed in the long term process, that are protection, conservation, valorisation, communication and fruition, should be coordinated in a systemic vision represented by the management. Therefore, on one hand PPC should be considered a management strategy for built cultural heritage, on the other hand it should represent an operational tool constituted by the conservation plan.

Cultural Districts project as the first step of PPC applied to the case studies analyzed

The case studies analyzed in the WP5 are located in the Lombardy Region and were already objects of the research developed in the context of the "Cultural Districts" project, a wide area programme mixing heritage and creativity for a local development strategy, co-financed by Cariplo Foundation (Barbetta et al., 2013). It was examined in depth in the WP2.
The first empirical experience of the Cultural District project is represented by the pilot project "Magistri Comacini" developed between 2001 and 2005 on Lake Como (Della Torre and Pesaro, 2002; Pedrazzini, 2005; Della Torre, 2005). It was based on a formal agreement signed by the Lombardy Region, Cariplo Foundation and several public and private partners and it was financed with a 6 million euros grant. Subsequently, in 2005 Cariplo Foundation trusted a pre-feasibility study to the Politecnico di Milano aimed at defining a project called "Cultural Districts as a tool for economic and social valorisation of local cultural heritage". It was directed at promoting new forms of territorial development through cultural heritage conservation and valorisation and through activities guaranteeing dynamism and sustainability for the future development of some local areas (CHCfE, 2015). Starting from 2009 six Cultural Districts were launched for the implementation of the project in six different areas of the Lombardy Region: Valle Camonica Cultural District, Dominus Cultural District, Regge dei Gonzaga Cultural District, Monza and Brianza Cultural District, Cremona

Cultural District and Valtellina Cultural District. In 2015 the start up period ended and currently each Cultural District is following an autonomous path, pursuing new activities and trying to evaluate the results.
The Cultural District project also represented an opportunity for innovation and change, as it was directed at introducing a new approach in conservation practices: a shift from restoration to preventive and planned conservation, shared methodologies and procedures oriented to a long term vision, costs control, quality of the works and the procedures, adoption of monitoring and evaluation systems (Moioli, 2013). Some of the notions acquired are: restoration is one phase of the conservation process, the restoration design proposes and plans the new function, the project has to be accompanied by a management plan, a conservation plan for a medium-long term has to be provided, the valorisation activities have to be designed as well (Petraroia, 2014).
Specifically, the activities developed in the WP5 analyzed some of the pilot projects started in the following Cultural Districts:

- **Monza and Brianza Cultural District**: It was conceived as a model for a local development driven by culture and built cultural heritage. The main strategic vision was focused on culture as a unifying factor and the creation of synergies between tangible and intangible heritage (Della Torre and Moioli, 2012). Regarding these issues, specific actions were developed: conservation works on built cultural heritage (Ca' dei Bossi in Biassono, Da Corte Castle in Bellusco, the Stables of Borromeo Arese Palace in Cesano Maderno and the Spinning Mill in Sulbiate), the creation of a front office for the PPC (Moioli, 2013), the organization of training courses and the development of cultural and creative activities. The District was composed by 12 partners and stakeholders from several sectors were involved. In fact one the aims was the creation of a stable network between the cultural and economic systems. Thus, the strategic areas of work were: culture, identity, training and innovation.
- **Valtellina Cultural District:** It was about a multi-year programme for the enhancement of the Valtellina territory based on a closer relationship among landscape, traditional production and cultural identity, through an integrated process of cultural heritage valorisation. The main initiatives in the program concerned the valorisation, networking and protection of the tangible cultural heritage (the Road of the Terraces, intervention in S. Antonio in Morbegno, intervention at Castel Masegra in Sondrio, realization of a circuit of palaces and castles in the Tiranese, construction of a water park/museum in Alta Valle) and intangible cultural assets (promotion of typical products through new technologies, research in archaeological and cultural heritage, training at various levels) of the Valtellina territory, in terms of innovation and social/economic development.

The two above mentioned projects showed different ways to develop the idea of PPC during the intervention planning phase. Starting from an analysis of needs, the search for sustainability on the long run ended in interesting experiments, which had a common feature: people involvement and capacity building were taken as decisive factors for innovation through heritage sector (Della Torre, 2015).
It is worthwhile to also underscore that the development of the two projects was implemented with a continuous collaboration with the academic environment, where the Italian way to PPC was born. Therefore, a learning community was created, strengthened by exchanges at different levels.
Furthermore, the opportunities for the development of the projects were enhanced by relevant, although not always consistent, policies promoted by National and Regional Governments, and by Cariplo Foundation.

Case studies analyzed

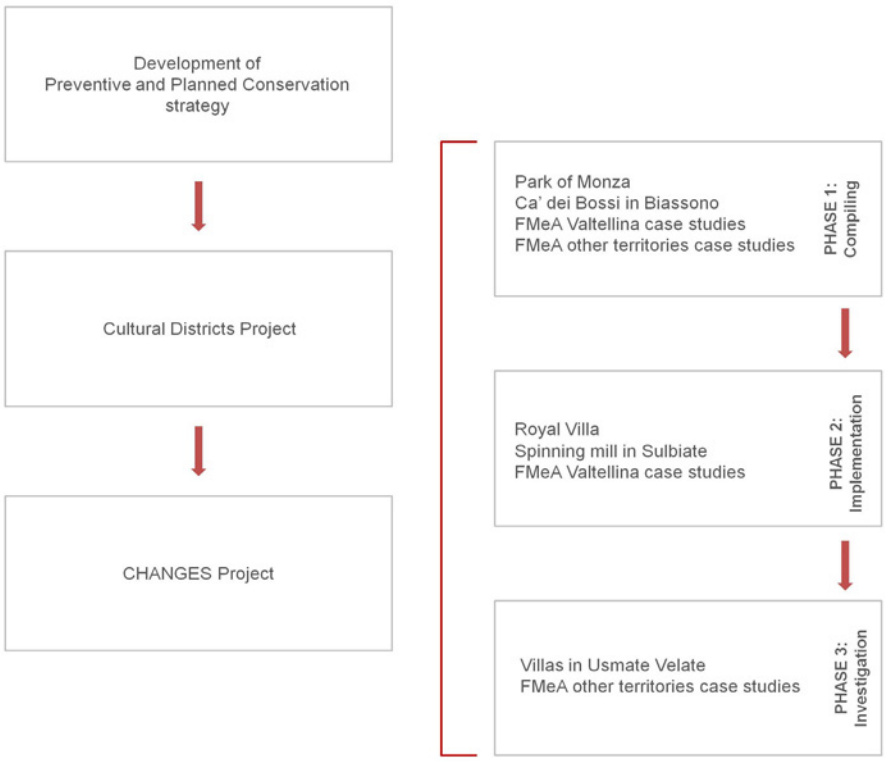
Therefore, the pilot projects identified enrich the sample with data referred to properties where management systems were previously implemented and stakeholders had experiences with these kinds of problems. They provide data related to conservation practices in terms of cost/efficiency of a post-intervention maintenance system.

Also thanks to the associate partners, that are the Consortium Royal Villa and Park of Monza, Navarra Gestioni (Na.Gest) and Assimpredil ANCE, the following pilot projects were analyzed by the ABC Department of the Politecnico di Milano (PI 1):

- **Royal Villa and Park of Monza**, Province of Monza and Brianza: it represents a huge cultural property, where a relevant conservation and valorisation project and good maintenance practices were developed.
- **Spinning mill in the Municipality of Sulbiate**, Province of Monza and Brianza.
- **Villa Scaccabarozzi and Villa Borgia in the Municipality of Usmate Velate**, Province of Monza and Brianza.
- **Ca' dei Bossi in the Muncipality of Biassono**, Province of Monza and Brianza.

Moreover, the following pilot projects were analyzed by the consulting engineers Foppoli Moretta e Associati - FMeA (PI 5). They are strictly related to the condition assessment of the buildings (safety for accessibility, safety for seismic events and safety for structural problems), with a focus on their physical state of conservation. The case studies were identified in the territory of Valtellina Cultural District (Sondrio Province – Lombardy), where it has developed a strong awareness of the utility of conservation activities for cultural heritage buildings. The activities were also developed in other Lombardy Provinces (Cremona, Como, Lecco, Varese) and in other territory out of Lombardy, similar because of their belonging to the mountain Alpine context such as the nearby Veneto and Trentino Region, in order to disseminate information, to test applicability of the methodologies and to compare technical and economical data:

- **Territory of Valtellina Cultural District (Sondrio Province) case studies**: S. Perpetua and S. Romerio in Tirano, S. Brizio in Vervio, S. Maria and Oratorio of S. Alessandro in Lovero, Ponte di Ganda in Morbegno, Palazzo Besta in Teglio.
- **Territory of other Lombardy Provinces case studies**: S. Agostino and Torrazzo (Cremona), Palazzo Prinetti (Lecco), Cascina Monastero Castelseprio (Varese), Ciminiera di Cremia (Como).
- **Alpine territory of other Italian Regions case studies**: Tempio Ossario in Bassano del Grappa (Vicenza), Arco Castle in Arco (Trento).



Representation of the level of analysis of the different case studies.

CASE STUDY N. 1: ROYAL VILLA AND PARK OF MONZA

Relevance of the case study

The development of WP5 upon the case of the Royal Villa and Park of Monza required the involvement and the coordination of both the public and private subjects involved: from one side the public owner, constituted of the associate partner Consortium Royal Villa and Park of Monza, from the other side the private tenant, constituted of the associate partner Navarra Gestioni.

The case study of Royal Villa and Park in Monza is interesting from several points of view: it is one knot of a larger net, the wide area Cultural District project, it is a complex system made of one royal residence, thirty-four minor historical buildings and a huge historical walled park of 734 ha; it is an interesting implementation of the Public-Private Partnership (3Ps) as a management model for the noble area of the Villa (Boniotti and Della Torre, 2016); it is an example of how the integration between conservation and valorisation is mandatory for a correct and effective management of the site and, finally, it is a perfect case for testing the effectiveness of economies of scale originated by the PPC strategy applied to a group of buildings.

Moreover, the Royal Villa and Park of Monza is a national relevant cultural site given the variety and the complexity of the system of historical buildings and historical/natural environment. This complex is the fulcrum of a broader regional system and it can play a central role in the local economic development.

Purpose

The case study of PPC applied to the Royal Villa and Park of Monza was already one of the pilot projects within the general framework of Monza and Brianza Cultural District. Starting from an in-depth analysis of the Royal Villa, which represents a recent conservation and valorisation intervention developed by both public and private subjects, the work aimed at defining an operative model for the management of complex properties, at communicating good practices for the maintenance of the built heritage and at identifying the priorities for the interventions.

Methodology

The research project foresaw a first collection of data and information related to the previous conservation activities executed upon the case study, the design of a conservation plan in all its parts (technical handbook, conservation program, economic budget, user handbook) through an information system dedicated to the conservation of built cultural heritage, and its fulfilment. In the meantime, a context analysis of the Royal Villa and Park of Monza was developed, with a specific attention to the diversified historical buildings located in the park.

Implementation of maintenance systems in the Royal Villa

The implementation of the PPC was applied on the central part of the Royal Villa thanks to the concessionaire willingness to test this methodology, which is composed of two main actions:

- **Prevention**: preventive actions are all those activities that are based on the risks assessment and thus are focused on the mitigation of all the harmful external conditions.
- **Planning**: as conservation has been defined as a circular process it is necessary to plan all the conservation activities in a proper span of time, in order to be more timely and cost effective.

Given the quantity of the information that PPC produces and the heterogeneity of the involved actors, the complexity of the program requires an implementation method able to manage the whole process: the **conservation plan** is the tool for the data organization and for the planning of the conservation activities concerning the building. It puts the economic component into long-term programming and allows the information exchange among the subjects involved in the process. In Italy the conservation plan was introduced in the 2000s as the equivalent of the maintenance plan for historic building, mandatory in the

sector of public works. It is a tool for filing information related to the building and for explaining the strategies to convert the instrumental role of the programmed maintenance into the strategic role of planned conservation (Della Torre, 2013; Della Torre, 2014).

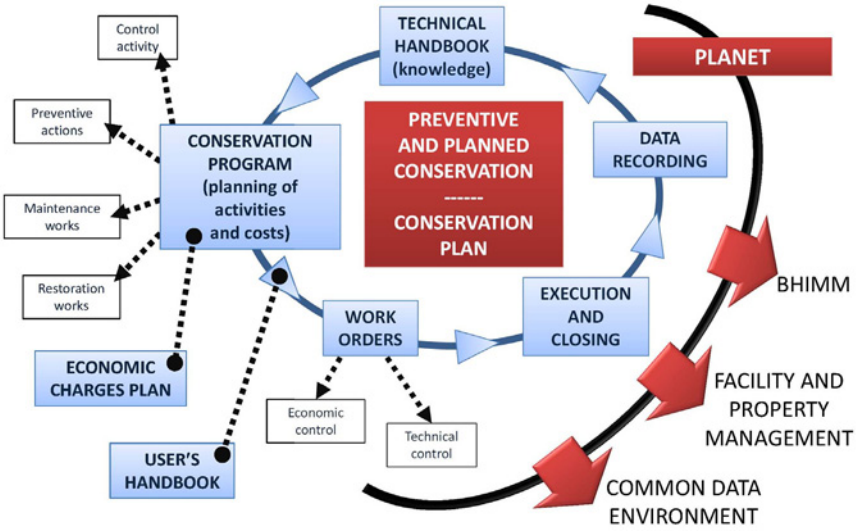
The conservation plan [Annex 1] elaborated for the Royal Villa was composed of:

- The **technical handbook**: it is the instrument for the analytic description of the building and its conservation condition [Annex 2].
- The **conservation program**: it constitutes the list of the scheduled conservation activities (according to the Italian law for protection of cultural heritage: prevention, maintenance and major interventions). It also includes information about how, when and by whom the activities should be carried on [Annex 3].
- The **economic budget**.
- The **user handbook**: it is the guideline for the non-technician users (cleaning teams, keepers, and visitors) [Annex 4].

The procedure of compiling and managing the plan was divided into three phases: setting up, drawing up and carrying out. The conservation plan represents a dynamic tool and is enriched with the recording of the events that affect the architectural organism in the course of time. The updates transversally concern all the documents in the plan: the technical handbook has to be updated with the information derived from the inspections and the implementation of the activities foreseen in the program; the conservation program has to be fine-tuned on the basis of the results of the above cited activities as well as of the economic budget.

The conservation plan was implemented through the adoption of the information system **Planet – Beni Architettonici** for the facility management of the conservation activities. Planet – Beni Architettonici is a platform specifically developed for the implementation of the conservation plan. It offers the opportunity to manage large amounts of data in a dynamic way, through queries and statistics. The most interesting features are: a direct link between data and documents attached, a web based system allowing the access to multiple users (even with differentiated levels of access), the interoperability with other information systems and the possibility of querying and creating statistics. The information system adopted was specifically conceived for the built cultural heritage within the "Monumentenwacht Italy" project as the evolution of the information system "Planet Maintenance", widespread in the facility management sector (Benatti et al., 2014).

Thanks to its compatibility with other management systems, Planet was integrated with the information system **Manpro.net**, which was used for the plants maintenance and for the property management (also planning of human resources and activities). The interaction between the two information systems allowed the coordination between conservation and valorisation activities.



Specifically, as the Royal Villa conservation plan was developed after the restoration works, it was possible to collect data from the project and the restoration site. Thus, a large amount of information was available, from the material characteristics up to the intervention costs resulting from the price lists (Lai and Pili, 2014). Planet allowed the organization of data within a hierarchical structure configured by levels, from general to detail, where each element was identified by a code. The information related to each element is available to the various professional figures involved in the process. Data entry and management within Planet are carried out through thematic panels organised for sections according to the different documents of the conservation plan.

The **work flow** was quite simple and logic:

- The first step was the drawing up of the plan documents filing the data in the information recording section.
- The second phase was to schedule all the activities, with the indication of the required technical skills and of the costs.
- The third step was the creation of for the "work orders", which allow the economic control through the contract management, the work accounting and the technical control through operational flow definition. They keep traceability of all the events (Benatti et al., 2014). Specifically, the work order is developed through three phases: opening, execution (i.e. the activities explained below), closing [Annex 5].
- Moreover, the fulfilment of the conservation plan. In fact, a first inspections plan was carried out during the period between August and October 2016. During the inspections activities the operators, the means and the time scheduled were defined. The working group was constituted by a conserver/restorer from Na.Gest and an architect and an engineer from the Politecnico di Milano. During the inspections, a group of maintenance workers supported the monitoring activities in assembling lifting equipments and executed small maintenance activities.

  The assignment of each activity depends on the inspected object, the decay typology and causes and the interactions between the technological elements.

  The means and instruments employed during the inspection activities were: the inspection report, a digital camera, a ladder, a mobile scaffolding and binoculars. The decays were investigated through visual controls or through a direct contact with the technological elements. In parallel with the inspections, a photographic campaign was performed at two levels: a general one to understand the general condition and a more detailed one to record specific decays.

  The data collection was developed in two phases: the first one, on site, through the compiling of the inspection reports, the second one through the implementation of the Information System Planet [Annex 6].

The conservation activities were scheduled according to the calendar of the valorisation activities: for example, the maintenance work of the wood flooring with the waxing was planned between the end of an exhibition and the setting up of the following one, in order to avoid the interruption of the **use**. Furthermore, a time schedule that defines when the inspection activities should be executed was defined (Gantt chart), on the basis of the availability of the spaces, in order to avoid the overlap with the normal fruition/events of the Villa [Annex 7]. The information related to the time schedule were subsequently reported in a calendar [Annex 8] and in a plan with the visualization of the calendar [Annex 9]. It is important to highlight that the work time considered is comprised of both the execution of the inspections and the following implementation of the data in the Information System Planet.

In compliance with the basic principles of the PPC process, **long-term planning is the premise for a rational management of economic resources**. In fact, the monitoring activities were planned taking into account the costs of all the activities, the human resources and means necessary for ensuring the conservation. The costs evaluation was based on the distribution of the activities in a long-term schedule, avoiding the concentration of the expenditures and using the costs of the past interventions for the spending prevision.

The global vision of the activities and the related costs (means, procedures and professionals involved), allowed the definition of a correct time schedule and budget, in order to meet both the conservative and the economic needs. The outputs of the monitoring/control activities are the evaluation of the effectiveness of the restoration works and the detection of future specific risk situations. Thus this kind of activities have a preventive efficacy in order to avoid degradation or decay.
After this first trial period, the concessionaire will autonomously conduct the implementation of the conservation plan, ensuring the execution of the conservation activities and updating it.

Implementation of maintenance systems in the Park of Monza

The complexity of the Royal Villa in Monza – due to the presence of the annexed park where other historical buildings are located – also required an analysis on a wider scale. A management model was elaborated in order to define a complete and coordinated vision of this cultural and landscape heritage (Moioli and Konsta, 2017).
The Park of Monza is one of the major European historical parks, it is located at the northern part of the city, bordering five municipalities and it is passed through by the river Lambro. The extensive green area incorporates numerous complexes of historical buildings, such as villas, rural buildings, water mills, and monumental landmarks, which at present have been adapted to different functions, for example, agricultural and productive activities, residences, cultural and educational activities, accommodation and restaurants, leisure and sporting facilities. [Annex 10].
Many of these buildings present different problems concerning both their conservation condition and their functional adaptation. However, it can be noticed that they have also many common aspects: they are constructed with the same materials and techniques, and they are situated in the same context. A systemic approach to the problems was required in order to cope with the extensive size of the area, the large number of buildings, their different typologies and their functional diversity. The focus of the **methodology** was twofold:

- First, the analysis of the physical conditions of the built cultural heritage (condition and risk assessment) in order to define the intervention priorities and to plan the monitoring and maintenance activities.
- Second, the gathering of data related to the management aspects (property, functions, resources, policies and practices), with the intention to elaborate a synoptic framework which could form the base of a master plan.

The research was developed in four phases. The **first phase** started with the collection of the existing documentation, as well as the examination of similar activities carried out previously, with the aim to re-order the results. Subsequently, the gathered material was enriched with new information provided by visual observations, photographic survey and interviews on site.
The **second phase** concerned the data analysis and their registration and led to three record sheets [Annex 11]:

- **Analytical record**: it is ordered in the different technological classes and contains information about the materials and the techniques, the description both qualitative and quantitative of damages, and provides measures recommendation divided in: preventive actions, regular monitoring, maintenance activities, and repair or restoration interventions.
- **Summary record**: it concerns the overall evaluation of the building conservation conditions, defines the priorities and schedules the conservation activities on long-term.
- **Synoptic record**: it is related to the administrative information (name, address, cadastre), contractual terms (duration, annual rent), functions, technical data (surface area, volume, number of floors), technological systems (safety/certifications, warning and protecting systems).

In the **third phase**, the data were re-elaborated and translated into thematic maps and pie charts [Annex 12], bringing out in this way the quantitative aspects and highlighting their relevance regarding the

management issues. Specifically, the analysis regarded the occupancy, the functions, the overall conservation condition, the conservation condition of roofs and the profitability of the assets.
In the **fourth phase**, thanks to the crossing between the general/use information with the condition assessment, it was possible to create the basis for a master plan [Annex 13] which considered both the opportunity and the possibility of adding new functions or strengthening the existing ones according to a sustainable strategic vision in the long run. More in detail, on the basis of the results of the previous analysis, seven clusters were defined according to the typology of the buildings, the destination of use, their particular vocation and the management approach.

Results

Generally, the WP5 on the Royal Villa and Park of Monza contributed to:

- Implementation of an informative system aimed at ensuring conservation activities and optimizing financial and human resources.
- Definition of criteria for monitoring and intervention activities.
- Definition of a model for the management of a cultural heritage, taking into consideration the public use and the property and facility management.
- Evidence of the convenience of PPC in terms of costs and decays prevention (Della Torre, 2003c).
- Progress in protection measures.
- Awareness of conservation and valorisation as preventive activities.
- Effectiveness of private business models for maintenance.
- Dissemination of good practices.
- Creation of a network between the local stakeholders.

The Royal Villa of Monza represented one of the first applications of the conservation plan, as a tool for a long term strategy. Considering that the private tenant will continue to implement and update the system, statistical data will be available during the next few years and they will constitute the basis for the economic evaluation of the activities. It is important to highlight that an overall evaluation should take into account not only the economic aspects, but also the cultural and historical values guaranteed by a continuous conservation practice. In fact, the PPC allows to avoid substitution of elements, a consistent loss of materials and authenticity, that frequently occur in big restoration works.
However, it is possible to make first **qualitative evaluations** on the method adopted for the Royal Villa of Monza concerning:

- The effectiveness of continuous and planned conservation activities executed in a building opened to visitors.
- The costs breakdown over a long-term period.
- The autonomy of the conservation process management conducted by the concessionaire.

CASE STUDY N. 2: SPINNING MILL IN THE MUNICIPALITY OF SULBIATE

Relevance of the case study

The conservation process of the spinning mill in Sulbiate is one of the projects carried out in the framework of the Monza and Brianza Cultural District, specifically in reference to the strategic line dedicated to innovation and entrepreneurship. The building was selected mainly on the basis of the choice for its new function: a place to create innovation through art, technology and social capital. In fact, it constitutes an ongoing project and hosts a fab-lab for cultural and social purposes. This case represents a strong synergy between cultural heritage and creative enterprises (Arquilla and Barbieri, 2015; Arquilla and Zinzone 2017).
It is an industrial building dated back to the Twenties of the Twentieth century and abandoned since 1970s. In 2009 the Municipality of Sulbiate signed an agreement with the private owner, who transferred the property to the public body as a tax burden for the construction of a new residential complex. The operation was justified by the high symbolic and emotional value of the building for the community. In 2016 the spinning mill was restored and currently occupies a space of 808.68 square meters, hosting a maker space, a co-working area, a centre for artistic and cultural experimentations, a food and drink corner.
It is an example of both an innovative built heritage conservation project and a management model. Since the conservation project and the management issues were thought as part of a unique process, it could be considered as a case study of change. Therefore, in this case the analysis was focused on the management model and on the set up of a monitoring and evaluation system of the conservation process.
Besides, the case study is interesting because many data were available and it was also possible to work with the actors involved in the process, creating a learning laboratory. These two aspects represented the basis for the definition of an evaluation model of the conservation process.
Moreover, thanks to the network established during the start-up period, developed by the Cultural Districts project, the spinning mill won a competition called ASTER, a call issued by the Lombardy Region for entrepreneurial projects. The total amount of the grant was 895,000 euros for the restoration works and the implementation of activities supporting the start-up companies settled in the spinning mill.

Purpose

The main aim of this case study was to create an **evaluation system for the long term management** of the activities, on the basis of the criticalities and the strengthens of the adopted practices (reflecting on methodology, operation choices and results). The evaluation of the impacts generated by the restoration of the spinning mill in Sulbiate took into account the whole process of conservation and valorisation: the framework project constituted by the Monza and Brianza Cultural District and the conservation process triggered in a long term run vision.
The work was also oriented at supporting the Municipality in the management activities. Many technical meetings suggested interesting and alternative hypotheses for the management model.

Methodology

After the restoration works, the JPI project CHANGES allowed to start the **collection of data coming from the monitoring system** filled in during the start-up phase and the **gathering of all the design and site documents**, included the maintenance plan. Interesting information also derived from the periodic **interviews** to the working group composed by the representatives of the three subjects in charge for the management of the spinning mill.
After a first recognition of all the available materials and the organization of the periodic meetings with the management group, it was possible to define an **evaluation model** which assess the process developed from the beginning of the restoration till the signing of the contract and the forthcoming management activities.

The aim of the evaluation activity is to assess both the impacts on local (regional) milieu in terms of creation of innovative processes and the sustainability of the challenging path undertaken by the Municipality of Sulbiate. Therefore, on one hand the evaluation model took into account the **quality** of the process detecting strength and weak spots, on the other hand the study foresaw the analysis of the achieved results from a **quantitative** point of view through the cost/revenues indicators.

Implementation of maintenance systems

The WP5 on the spinning mill in Sulbiate consisted in a **qualitative evaluation** of the activities carried out during a four year period, starting from the restoration works to the management of the building. The analysis tries to highlight for each achieved result the positive aspects, but also the criticalities encountered.
Concerning the **public procedure**, the choice of adopting a public tender based on quality and not only on the minimum offered price constituted a successful option and a best practice. Even if usually these types of tenders are considered a hazard, difficult to put into practice and expensive for the nomination of a committee of experts, it has been demonstrated that these kinds of public tenders are more motivating: professionals and building contractors are obliged to understand the needs of the client, to share the methodological approach and to provide well thought-out proposals, also from the economic point of view. However, some criticalities can be identified, as the fact that the procedure took some additional time and the decision to change designer in each of the three design phases. Moreover, one of the public tenders was drawn up by the Province staff in collaboration with the Municipality officers. It was a test of collaboration among different public bodies. The positive aspect was the support provided under the administrative point of view and the main criticality was the excessive time needed for the bureaucratic steps.
Since the first designing phase many **communication activities** were developed. A first successful opening of the spinning mill, still in bad repair conditions, hosted almost five hundred visitors: during the annual event called Ville Aperte (open monuments), the spinning mill was opened to the public and it became the stage of a site specific performance of contemporary theatre and dance, created in the frame of the pH - performing Heritage event. In the following years the spinning mill was regularly opened to the public for the annual Ville Aperte event, also during the restoration site.
Besides these communication activities, also more **participative actions** were put into practice. Thanks to ASTER funds, the Department of Design of the Politecnico di Milano, which was a partner of the project, created a working group composed by different stakeholders, in order to spread the habit to develop bottom up processes and to train a group of social actors able to apply for public tenders (such as the one for the management of the spinning mill). The interesting features were the bottom up approach and the attempt to integrate the restoration issues with the future functions, taking into account also the management model.
At the end of the restoration works in 2016, the Municipality published the **public announcement for the space/activities management**. The call for tenders included issues related to built cultural heritage as a driver for changes in the management activities and developer of positive and sustainable effects (local community, economy, environment and culture). In fact, the call required subjects able to: think innovative ideas; create contamination processes among art, design, making, handicrafts, media and food; demonstrate to have the financial structure for the management and the valorisation activities. The call clearly stated that the aim of the spinning mill was to generate new production processes and to activate partnerships with enterprises, craftsmanship and public bodies by means of mentorship, valorisation of micro-companies for not mass-produced objects. The winner of the public competition was a group constituted of three different subjects: a social enterprise, an association for social purposes and a cultural association. The Municipality and the subjects in charge for the management of the site defined the details of the contract and the governance of the project. It meant a precise delineation of the roles of each subject, the monitoring and the expected outputs, as the objective was to promote a place for private workers maintaining a public interest.
This was a first attempt of an improvable practice. For example, the subject in charge for the management could be chosen before the restoration intervention. However, the Italian law for the concession of a public

space/building foresees a public tender, in which the technical attached documents require all the information about the characteristics of the building and the systems, as well as the costs for the ordinary run management of the building. The participants to the call have to use such information for the submission of a detailed economic-financial prospect and a business plan. It is clear that in case of a restoration intervention, it is not so easy to comply with these rules. Probably it would be necessary to create an even more tailored process.
The most relevant conditions identified in the **formal agreement** are: the building keepers pay a rent to the Municipality and undertake the ordinary operating costs; two open days per year and four events per year involving local schools must be guaranteed; the typology of activities have to be submitted to a scientific committee; training courses and networking with local social/economic subjects have to be included in the annual programme.

Moreover, the activities developed within the WP5 also implied a **quantitative evaluation** for the definition of a model for the sustainability assessment.
The **costs for the restoration works** included: Cultural District staff, administrative activities, works, communication and valorisation activities.
The **costs for the management** of the spinning mill include: conservation activities on the long term, use and valorisation (rent, spending for the bills/cleanings/facilities, local taxes, costs for the implementation of the activities).
The proposed evaluation system highlights the importance to consider not only the amount of the total expenditure, but also the typology of funders, as some reflections can be made on the distribution of costs between public and private subjects.
According to this criterion, it was interesting to compare in detail the **expenditure** borne by the public owner and by the private subject responsible for the building management:

- At the expense of the Municipality: costs for the scientific committee, the implementation of the PPC activities for the first four years and the related administrative procedures.
- At the expense of the private subject: costs for rent, insurances, bills, safety, management of each organization (taxes, salaries, specific insurances, etc.) and communication activities.

Besides, **revenues** were calculated:

- For the Municipality the incomes derive from: the rent, considering the financial point of view. Furthermore, it is important to assign a monetary value also to the public fruition guaranteed by the use of the spaces, constituted by the possibility to organize for free public initiatives for 50 days per year.
- For the private subject the incomes derive from: the core activities of each of the three organizations, sublet of spaces, training courses, production and sales of design objects, drink, food and sponsorship. Furthermore, it is worth notice that the nature of the project makes this subject eligible for other public funding.

Results

The spinning mill was a private building, probably destined for demolition, which was acknowledged as a cultural heritage for its intangible value linked to the collective memories of the inhabitants. The public challenge was to acquire and restore it with the less expenditure as possible, to avoid to transform it in an economic burden not sustainable by the public body and to return it to the people as a cultural and public good, but with a social and economic role.
The activities developed in this case study demonstrated that **built cultural heritage could be a resource and not only a cost for the public budget and for the community**. Following, other points of interests emerged:

- The **effectiveness of a well planned conservation process**.

- The **different roles of public and private subjects** in a partnership focused on cultural, social and economic activities. Specifically, the Municipality had always a clear vision of its tasks and role: the responsibility of making the public investment effective, the objective to guarantee the collective interest and the duty to preserve the building. In a partnership the public body has both to control and to support.
- The **participation of the community** in the past, but also in the future of the spinning mill.

Moreover, there are still some open questions:

- Which should be the break even point between the public funding and the private investment?
- Should the private subjects be financed again by the public sector, considering that they are “working” in and for the cultural heritage?
- How the conservation of the building can continue to be a priority?

CASE STUDY N. 3: VILLA SCACCABAROZZI AND VILLA BORGIA IN THE MUNICIPALITY OF USMATE VELATE

Relevance of the case study

Villa Scaccabarozzi and Villa Borgia were built during the Nineteenth century and are located in Usmate Velate, a small town located in the Province of Monza and Brianza.

The villas were chosen as case studies for the CHANGES project on the proposal of the public owner, the Municipality of Usmate Velate, thanks to the relations strengthened with its employees during some previous training activities on the Preventive and Planned Conservation.

The two public properties offered the possibility to work on case studies characterized by different conservation and management conditions, since the properties are currently used and are basically not in bad conditions.

It also represented the way to experiment the addition of the costs of the Preventive and Planned Conservation in the municipal budget.

Purpose

The work was oriented at supporting the Municipality in the management activities upon the two villas, specifically:

- Conservation and valorisation of the heritage according to the strategy of the Preventive and Planned Conservation.
- Investigation on solutions for conservation plans conceived for specific cases.
- Construction of a long term program of priorities and conservation activities.

Methodology

At the base of the strategy for the conservation of the building, there is the necessity to find a use compatible with the heritage characteristics. If it is fundamental to physically conserve the building, it is unavoidable that the continuous use should imply a continuous care, triggering monitorings functional to the maintenance and the valorization of the building. The conservation plan aims at optimizing the resources invested for the restoration of the asset, implementing a preventive strategy and maximizing the permanence of the material authenticity.

Therefore, the conservation plans of Villa Scaccabarozzi and Villa Borgia were implemented by a practitioner designated by the Municipality in close cooperation with the Politecnico di Milano and the Monza and Brianza Cultural District.

The CHANGES Project gave the possibility to have periodical meetings with the public works office directed at updating the conservation plans across the years and elaborating some first ex-post considerations.

In a future perspective, this methodology could be adopted also to the entire complex that characterizes the villas (park, square, etc.) and to all the public buildings, in order to constitute a management instrument on a large scale.

Implementation of maintenance systems

The following activities were developed in order to guarantee the implementation of maintenance systems for Villa Scaccabarozzi and Villa Borgia:

- **Collection and organization of available information**.
- **Definition of the structure of the conservation plans**.
- **Definition of the budget**.
- **Compilation of the documents that constitute the conservation plans**. Specifically, this part entailed:
  - Design of plans and sections that reproduce the current state of the villas.
  - Identification of each technological element of the spaces, in order to facilitate the detection, reporting the code referred to each technological element in the design.

  - Take pictures of the spaces and of the technological classes of the villas.
  - Compilation of the conservation plans in all their parts: technical handbook, conservation program, economic budget, user handbook.
- **Definition of the program of the conservation activities**.
- **Community involvement**.

Since the conservation plans of the two villas are directed at reaching different goals, they were structured in two different ways:

- In the case of Villa Borgia the conservation plan was implemented on the basis of the technological classes. It was not necessary to identify further classifications because the building presented uniformity in terms of materials, techniques and state of conservation [Annex 14].
- In the case of Villa Scaccabarozzi the conservation plan was implemented on the basis of rooms or technological classes, depending on the spaces and their similar characteristics.

During the following phase, the first inspections were executed through both visual observations and tests, as indicated in the conservation plans. The information were reported in the plants, obtaining a map with the "problems". In this way the construction companies could accurately identify the elements that required maintenance, preventing the waste of resources.

The inspections are usually executed every six months, in parallel with the control of the fire protection systems. Conservation activities of various types were performed: verifications and repairs of electrical and hydraulic systems, limited building works, blacksmith's works, etc [Annex 15].

Following this procedure, the Municipality realized that it could achieve savings on the public spending dedicated to maintenance. This is an important aspect considering that the financial resources for conservation activities are becoming more and more limited.

Another phase of the project was represented by the **elaboration of some qualitative and quantitative data** related to the maintenance works executed upon the two villas during the period 2010-2015. The activities implemented during the years 2012-2013 and 2014-2015 were influenced by the introduction of the pilot projects in the Cultural Districts program.

A first consideration is related to the percentage of the expenditure dedicated to building works: in the first three annualities it is less than or equal to 10%, during the Cultural Districts project it is more that 30% of the total expenditure.

	2010-2011	**2011-2012**	**2012-2013**	**2013-2014***	**2014-2015***
Costs for building works	1.350	728	678	3.638	14.726,44
Total expenditure	13.848	14.917	10.988	11.320	45.171
Incidence	10%	4,8%	6%	32%	32%

* During the Cultural Districts project.

A second consideration can result from the comparison between the incidence of the costs of planned activities and the total expenditure (non-planned activities are considered the ones executed due to damages or for the maintenance of the systems).

	2010-2011	**2011-2012**	**2012-2013**	**2013-2014***	**2014-2015***
Costs for planned works	3.064	4.440	737	4.925	14.726,44
Total expenditure	13.848	14.917	10.988	11.320	45.171
Incidence	22%	30%	7%	44%	92%

* During the Cultural Districts project.

The comparison between the two tables allows to deduce that the increase of building works in the last two years was exclusively related to activities of Planned and Preventive Conservation.

Another aspect may be the evaluation of which are the expenditures for damages that could be avoided assuming a preventive approach, through periodic inspections, above all on the systems.

Results

The achieved results are represented by:

- Compilation and execution of conservation plans.
- Dissemination and awareness of the Preventive and Planned Conservation practice.
- Dissemination of knowledge derived from the implementation of innovative processes through the organization of local meetings, but also scientific discussions.
- Construction of an activities program to be developed in the long term period, based both on the priorities identified and on the purchasing power.
- Identification of cultural heritage management modalities that allow to optimize the use of public resources.

CASE STUDY N. 4: CA' DEI BOSSI IN THE MUNCIPALITY OF BIASSONO

Relevance of the case study

The building is situated in the historic centre of Biassono, four kilometres from Monza, in close proximity to the northern part of the Park of Monza.

The restoration works started in 2014 and are still in progress. The design of the conservation plan has started during the phase of restoration activities but it has to be completed after the conclusion of the works. In parallel, the valorisation plan foresaw spaces for cultural activities and various associations with the aim to respond to the social needs and to transform the building into a strong point for social inclusion.

The relevance of the case study consists in the importance of the definition of roles and participatory processes in the integration of conservation and valorisation activities.

Purpose

The work was aimed at supporting the Municipality in the management activities. Many technical meetings suggested interesting and alternative hypotheses for the management model.

In particular, the objective consisted in defining the contractual agreement between the public owner and the concessionaire in regard with their roles in conservation and valorisation activities.

Methodology

The methodology was based on the strategy of planned and preventive conservation and on the importance of integration of the conservation activities within the valorisation of the buildings.

Therefore, the approach adopted took into consideration both the implementation of the conservation plan and the definition of the appropriate use of the spaces.

The former was related to the specification of responsibilities of the two parties. In particular, since the maintenance activities are borne by the administration (in accordance with the Cultural Heritage and Landscape Code), the solution worked out consisted firstly in the estimation of the costs, and subsequently in their explicit mention in the contract and the compulsory participation of the concessionaire directly or by offering the corresponding services.

The latter was connected with the selection of the concessionaire. The judgement was based on the compatibility of the use with the conservation of the building.

Implementation of maintenance systems

In order to define the economic budget of the conservation activities [Annex 16] the CHANGES project, within the WP5, carried out the following activities:

- Collection of the worksite documentation.
- Site inspection and risk assessment.
- Definition of the Program of conservation activities.

The costs were calculated on the basis of the activities, the operators, the equipment, and the hours of work needed.

The table below summarises the annual and total costs of the conservation plan and the part of costs borne by the concessionaire, that are estimated on the basis of the percentage of the spaces occupied by each party.

	Spaces		Percentage
Concessionaire	rooms 21, 23, 28, 29	203.2 mq	35%
Municipality of Biassono	rooms 05, 06, 07, 11, 12	215.6 mq	37%
Association Gral	rooms 01, 02, 03, 15, 16	147.7 mq	28%
Common spaces	rooms 08, 09, 10, 19, 20, 22, 24, 27 (except elevators/stairs 04, 25, entrance space 14 and courtyard)	150.4 mq	
Total		**716.9 mq**	

	2017	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**
Annual costs of the conservation activities	11,816	6,816	6,816	6,816	8,307	13,597	13,597	13,597	13,597	15,088
Total costs	110,046 (annual average: 11,005)									
Total costs / concessionaire	38,516 (annual average: 3,852)									

Results

The results achieved are summarised below:

- Dissemination of the Preventive and Planned Conservation strategy.
- Identification of cultural heritage management models that allow the optimization of the allocation of the public resources.
- Integration of the conservation and valorisation activities in the management model.
- Definition of the role of the contracting parties in the conservation and valorisation activities.

INTRODUCTION TO VALTELLINA CULTURAL DISTRICT, LOMBARDY REGION, ALPINE REGION CASE STUDIES

Relevance of the case studies

The partner Foppoli Moretta e Associati consulting engineers (FMeA) carried out the project CHANGES in three different areas with the aim to compare the opportunities and the results in connection with the local context: the territory of Valtellina, other specific areas in the nearby Lombardy Region and in the nearby Alpine territory of Veneto and Trentino Region.

Specifically, the Valtellina context was chosen as a case study, since it was already object of other interventions aimed at executing restoration and conservation activities on the cultural heritage. They were developed in different periods, as explained below:

- In the period from 1996 to 2003, after a severe flood event happened in 1987, dozens of monuments were restored thanks to a program financially supported by the law (L. 102/90) for the reconstruction of the Valtellina (Bormetti and Sassella, 2004). The interventions were executed in a limited period of time, with similar technology and restoration criteria. However, despite this relevant investment, this operation was not subject either to a subsequent planning of the maintenance of these buildings, either to the study of the use for the promotion and development of the territory. Nevertheless, the process produced an increase of the skills of the local practitioners (Della Torre, 2010).
- In the period from 2006 to 2009, the project "Antica Pieve di Mazzo", promoted by Cariplo Foundation, was developed. The importance of the project lay in the integration of valorisation activities into the conservation process with the contribution of the local authorities, parishes, cultural associations, social cooperatives and university (Foppoli et al., 2008).
- Subsequently, in the years 2009-2011, a significant program of accurate diagnostic campaign and planned conservation for the built heritage was carried out as part of the project "Dissemination of innovative technologies for the planned conservation of historical architectural heritage" promoted by Cariplo Foundation. The project was supervised by specialists working in the territory in collaboration with important research institutions, such as the ABC Department of the Politecnico di Milano and the CNR - ICVBC of Milan (Foppoli et al., 2009; Foppoli and Besana, 2009; Foppoli et al., 2011; Foppoli and Guiducci, 2014).
- From 2011 the Valtellina Cultural District financed inspections on many monuments and a lot of educational activities, which fostered an active and innovative environment in the built cultural heritage context. In particular, the activities led to the joint organization of an Italian-Swiss workshop titled “Experiences for the Planned Conservation of the Historical Heritage of Valtellina”, which involved more than 50 technicians and restorers.
- With the aim of developing the partnership activated within this project (Valtellina Cultural District), in 2013 the European Interreg project “Planned Conservation in Common Rhaetian Area” (CPRE) was launched (Foppoli et al., 2014).

These projects allowed the definition of virtuous intervention modes through the most advanced techniques for diagnostics, restoration, maintenance and management of cultural assets, which were developed by interpreting conservation as a long-term process.

Considering the relevance of the activities already conducted in this local context, the work developed within the WP5 tried to pursue the actions started within the above described projects.

Furthermore, the WP5 was aimed to evaluate the possibility of disseminating similar activities out of the local context of the Valtellina Cultural District, specifically in the nearby Provinces of Lombardy and in the nearby Alpine Region (in Veneto and Trentino Regions). These areas have similar social, economic and environmental conditions and for this reason they can be considered suitable for the extension of the applied methods.

Below, a synoptic table summarizing all the interventions mentioned.

Project	Period	Buildings	Activities
L. 102/90 (reconstruction after 1987 flood)	1996-2003	70	Restoration works: total amount € 30.000.000
Antica Pieve di Mazzo	2006-2009	Bellaguarda Castle in Tovo, Lavizzari Palace in Mazzo, S. Maria Church in Lovero, (Antica Pieve di Mazzo).	Restoration and valorisation.
Innovative technologies	2009-2010	Besta Palace in Teglio, Besta Manor in Bianzone, S. Ignazio Church in Ponte, Masegra Castle in Sondrio.	Diagnosis and monitoring.
PPC (ITALY)	2009-2014	Besta Palace in Teglio, Masegra Castle in Sondrio, S. Antonio Monastery in Morbegno.	Conservation plan.
PPC (SWITZWELAND)	2009-2014	S. Martino Church in Zillis, S. Giovanni Monastery in Mustair.	Conservation plan.
Cultural District of Valtellina	2011-2015	40	General inspections. Educational activities.
CPRE Interreg project	2013-2015	30	Structural inspection. LV1. Educational activities.

Purpose

Therefore, FMeA supported Politecnico to collect information related to the activities of Preventive and Planned Conservation executed on historical buildings placed in these contexts, in order to evaluate the effectiveness of the interventions.

Considering the time elapsed since the first restoration works in Valtellina, it is always recommended to activate procedures of prevention and care, with inspections, constant monitoring and maintenance plans, in order to keep the state of conservation under control. Thus, the WP5 allowed to investigate on:

- The technical-scientific analysis of the data derived from the interventions carried out previously.
- A critical analysis of the current state of conservation.
- An analysis of the techniques of cultural heritage restoration.
- A proposal for a preventive conservation and valorisation approach.

The whole programme pursued some long-term objectives:

- Increase awareness and provide owners and managers of cultural assets with updated tools for predicting and preventing degradation and for planning a proper conservation policy.
- Build specific skills: in fact, the non-secondary objective of the activities and the essential positive relapse in the area was the involvement of local professional resources, in order to ensure over time the presence of adequate professionalism that will be able to take on the operational tasks of protection and conservation.
- Build appropriate premises for giving continuity to the initiative, for developing and disseminating conservation culture, for activating economies of scale and improving allocation of resources for preventive and planned maintenance.
- Valorise the data analysis and the discoveries resulted from the research through scientific publications, conferences and museum exhibitions on the territory.

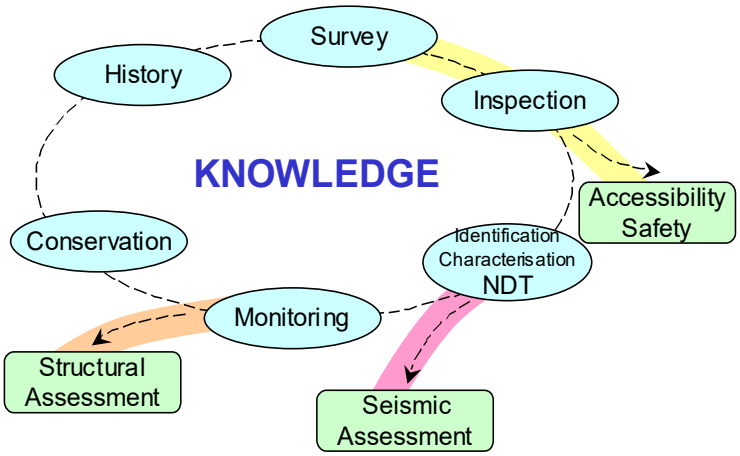
Methodology

The basic consideration is the assumption that conservation, and moreover safety, require as a prior condition a proper knowledge of the building. The objective to assess the safety of buildings from different points of view (accessibility, seismic and structural) was achieved by using tools provided by the methodologies adopted to ensure the preservation of cultural assets, such as:

- Historical research for the interpretation of the historical evolution of the construction.
- Geometric survey matched with the survey of crack and deformation pattern.
- Detailed inspections of the artefacts, to acquire accurate knowledge and to plan the maintenance activities.
- Structural identification of the building and its construction details **.
- Characterisation of mechanical properties of materials and their deterioration **.
- Characterisation of soil-foundation relationship **.
- Monitoring of the structural and environmental changes.
- Building Information Modelling used as a design tool.
- Conservation plans used as a maintenance and management tool.

The activities of structural diagnosis marked with ** in the list above and in the table below, specifically the ones performed through NDT, are obviously essential in the development of conservation process; however they are not the subject of the present research and so they are not specifically commented in the following chapters.

In the following sketch it is represented the path necessary for the knowledge of a heritage building, specifically aimed to the assessment of its safety.



Representation of the activities performed to deepen the level of knowledge of heritage buildings.

These activities were performed by FMeA within the WP5, in a number of case studies selected from buildings of different typologies and in different territorial contexts. They were chosen among typologies that are different but recurrent in heritage constructions, such as churches, castles, bridges, towers and bell towers. Some of the buildings selected to perform inspections are tall buildings and they required to operate with the use of ropes.

The seismic assessment was analysed at different Levels of Detail: LV1 (territorial scale), LV2 (local behaviour, macro-elements) and LV3 (overall behaviour). Also in this case the activities were performed on heritage buildings of different typologies such as churches, palaces, but also not usual typologies such as bridges or chimneys. The structural (and in some cases environmental) monitoring allowed us to implement the previous observations both on churches and palaces. It also provided in some cases additional information necessary to assess the static structural safety.

Implementation of maintenance systems

In order to assess the state of conservation of the selected buildings, the first phase implied the collection of the existing and available technical documentation. In this way, it was possible to identify the most widely used materials and techniques and to verify their reliability and durability over time.

The second phase was aimed to the individuation of any eventual degradations or damages caused by the lack of maintenance and included:

- Inspections.
- NTD – Non Destructive Testing.
- Monitoring.
- Seismic assessment.
- Conservation planning.

The activities were performed with the collaboration of the Politecnico di Milano and under the supervision of the competent Superintendence for the Architectural and Landscape Heritage of Milan.

Following a table with a synoptic list of the performed activities:

	Building	Inspections		Analysis & NDT	Seismic Assessment		Monitoring	Conserva-tion Plan
		Struct.	Arch.		LV1-LV2	LV3		
Valtellina Cultural District								
1	Tirano (SO): *S. Romerio Church*. (Graübunden - CH): *S. Perpetua Church*.			Yes**			Structural & environm. monitoring	
2	Vervio (SO): *S. Brizio Church*.				LV1 + LV2	LV3		
3	Lovero (SO): *S. Maria Church*.	X	X	Yes**	LV1		Structural monitoring	
4	Lovero (SO): *S. Alessandro Oratory*.	X	X		LV1 + LV2			
5	Morbegno (SO): *Ganda Bridge*.	X	X (ropes)	Yes**	LV2	LV3		
6	Teglio (SO): *Besta Palace*.			Yes**	LV1 + LV2		Structural monitoring	Analysed
7	Morbegno (SO): *S. Antonio Convent*.							Analysed
8	Sondrio: *Masegra Castle*.			Yes**				Analysed
9	Zillis (Graübunden - CH): *S.Martino Church*.							Analysed
Lombardy								
11	CREMONA: *Torrazzo Bell Tower*. *S. Agostino Church*.		X (ropes)					
12	Merate (LC): *Prinetti Palace*.	X	X (ropes)					
13	Castelseprio (VA): *Cascina Monastero*.				LV1 + LV2			
14	Cremia (CO): *Chimney*.			Yes**	LV1 + LV2	LV3		
Alpine Region								
15	Bassano (VI): *Ossuary Temple*.	X	X (ropes)	Yes**				
16	Arco di Trento (TN): *Castle*.	X	X (ropes)					

Results

Thanks to the activities developed during the CHANGES Project it was possible to:

- Acquire knowledge related to history, materials, constructive techniques, local context, but also awareness of the relation between the different forms of cultural heritage with different meanings or functions.
- Investigate on the effectiveness of the conservation activities carried out during the last 20 years.
- Evaluate the impacts derived from the adoption of new technologies during the conservation and management phases.
- Reflect on conservation as a systemic approach and a vision of long-term protection.

It was also possible to provide Politecnico di Milano with economic information useful to be processed in the following WP6.

In order to describe the activities carried out, some specific cases referring to different contexts and different stages of the research are outlined: the applied methodologies are presented, the obtained results are explained and the conclusions relevant to the present research are outlined.

- CASE STUDY N. 5 -SAFETY FOR ACCESSIBILITY - INSPECTIONS

  This case study aims at presenting the inspections activities that were performed to assess the safety for the accessibility in the surroundings of heritage buildings. The specific inspections are referred to the **Torrazzo Bell Tower** (Cremona) and the **Arco Castle** (Trento): these two buildings are located out from Valtellina, the first one in an urban context (Cremona) and the second one in a mountain context (Arco).

  In both the cases the main problem to investigate was the fall of blocks and bricks from the external surface of the walls that could involve the pedestrian passage in the surroundings of the monuments. In the case of the Arco Castle the additional problem was the fall of stone elements also from the internal surface of the walls, that is a big hazard in connection with the great presence of tourists in the internal path of the monument. The bell-tower is 112 m in height and the castle is placed on a step cliff very difficult to climb: because of these problems of accessibility, in both the cases it was necessary to use rope access and positioning techniques.
- CASE STUDY N. 6 - SAFETY FOR SEISMIC EVENTS - SEISMIC VULNERABILITY

  This case study is related to the assessment of safety against the seismic events.

  Besta Palace in Teglio (Sondrio) and **Cascina Monastero** in Castelseprio (Varese) are heritage buildings managed by the Regional Museum Pole of Lombardy. The specific relevance of these cases resides in the possibility of comparing the two buildings: it was possible to elaborate comparative considerations about the reached Level of Knowledge (LC) and the results of the seismic assessment at different Levels of Detail, LV1 and LV2.
- CASE STUDY N. 7 - SAFETY FOR STRUCTURAL HAZARD - MONITORING

  This case study deals with the complete set of activities aimed to reach the proper knowledge of a heritage building as sketched above. On **S. Maria Church** in Lovero (Sondrio), a building placed in the context of Valtellina Cultural District, the inspections (without the use of ropes) were performed to analyse the overall crack and deformation pattern. The monitoring was carried out for two years starting from the installation of the system. The results were matched also with analytical data taken from structural and seismic calculations. Thus, it was possible to obtain a proper interpretation of the relevant deformation and cracking phenomena. In this specific case it has to be underlined that the performed analysis led to the decision of avoiding the execution of difficult and expensive consolidation works.

CASE STUDY N. 5 - SAFETY FOR ACCESSIBILITY - INSPECTIONS
Torrazzo Bell Tower (Cremona) and Arco Castle (Trento) [Annex 17]

Introduction

The activities performed on the **Torrazzo Bell Tower** in Cremona were preliminary to the other inspection activities and were used with the goal to perfect the procedures:

- For operating with ropes.
- For sketching out the reports.

This second item will be described dealing with the next example of the activities performed at Arco Castle.

In compliance with the Italian Health & Safety Code for Construction (D. Lgs. 09/04/2008 n. 81), a specific qualification is necessary in order to operate with access and positioning systems through ropes. FMeA is provided with this qualification because its operators (Eng. Dario Foppoli and Arch. Michele Besseghini) are qualified both as worker and as responsible; moreover, they have a further specialization for rope access on historic and iconic buildings. It is relevant the fact that both the operators are technicians with a master degree and a high specialisation for assessing the structural conditions of buildings.

The Italian mandatory procedures related to this activity indicates the following necessary relevant documents:

- DVR = Risks Evaluation Document (drawn up by the operator).
- POS = Operative Safety Procedure (drawn up by the operator).
- DUVRI = Unique Interference Risk Evaluation Document (drawn up by the client).
- PSC = Safety and Coordination Procedure (drawn up by the client).

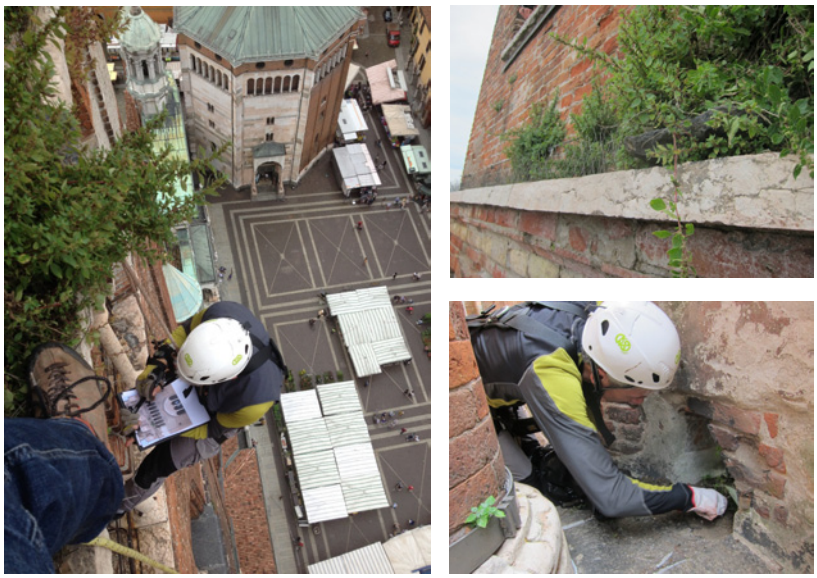
A further specific internal procedure was implemented by FMeA in order to foresee the filling out of the *scheda informativa di cantiere* (Site Information Sheet), as follows:

Torrazzo in Cremona, inspection activities: DVR (Risks Evaluation Documents) related to the identification of the access and escape ways.

Cremona Cathedral bell tower, named “Torrazzo”, is the highest masonry bell tower in Italy (112 m). Its construction started in XIII century; it developed in four phases and lasted a century.

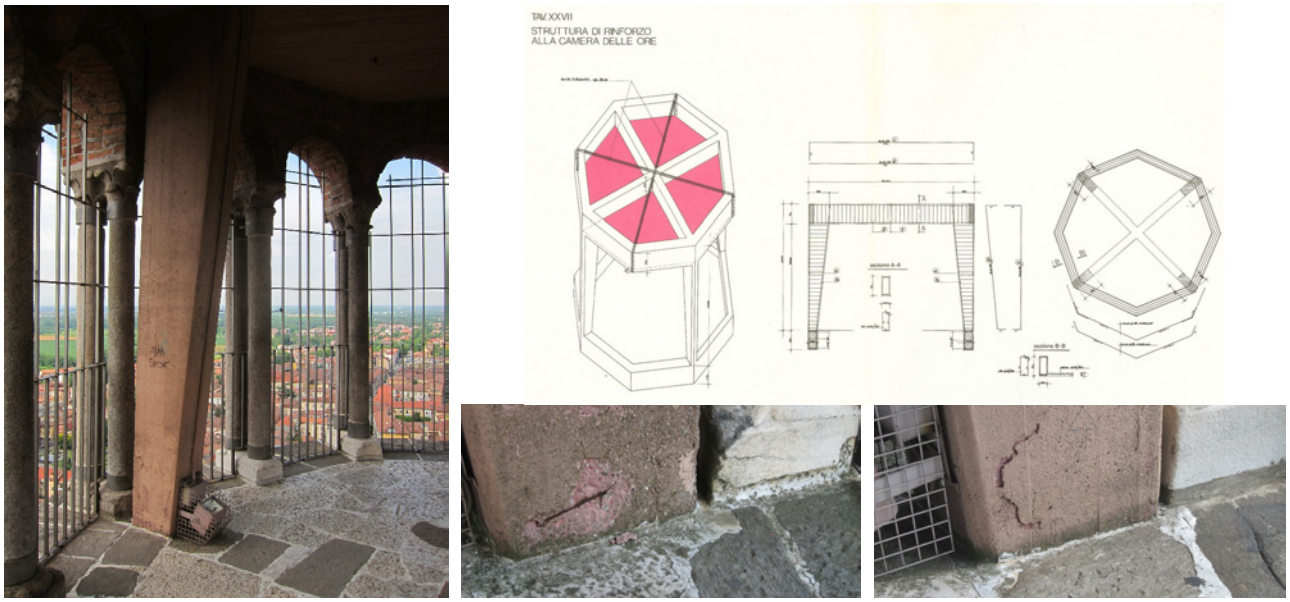
The inspection was requested by the Bishopric to analyse the causes of the growth of vegetation on the higher levels of the tower. Therefore, it was decided to operate from the base of the *Ghirlandina*, with access and positioning techniques by ropes. Specific forms were filled to report the relevant problems detected on the external surfaces of the masonry.

Torrazzo in Cremona.



Torrazzo in Cremona: inspection activities operated with access and positioning techniques by ropes;
the inspection proved that the growth of vegetation was mainly caused by the lack of maintenance of gargoyles.

The inspection proved that the growth of vegetation was mainly caused by the lack of maintenance of gargoyles. An additional problem was observed: in the 80's the *Ghirlandina* was strengthened with a reinforced concrete structure, that currently presents significant degradation signals that require further investigations.



Torrazzo in Cremona: in the 80's the *Ghirlandina* was strengthened with a reinforced concrete structure, that currently presents significant degradation signals that require further investigations.

The **Arco Castle** in the Province of Trento is a fortress built during the XI century, that is placed on a step cliff hanging on the city of Arco di Trento. In the following points some short information about its historical development are outlined:

- Archaeological remains states the presence on the cliff of settlements previous than medieval times.
- A castle built for defensive purposes by Arco's noblemen already existed around the year 1000.
- From the XIII century the castle became the property of the Household of earl of Arco.
- In 1703, during the war of Spanish succession, the castle was seriously damaged by the French bombings; it was later abandoned and went to ruin.
- In 1982 it was purchased by the Municipality.
- In the last decades of the XX century the castle was restored by Trento Superintendence.

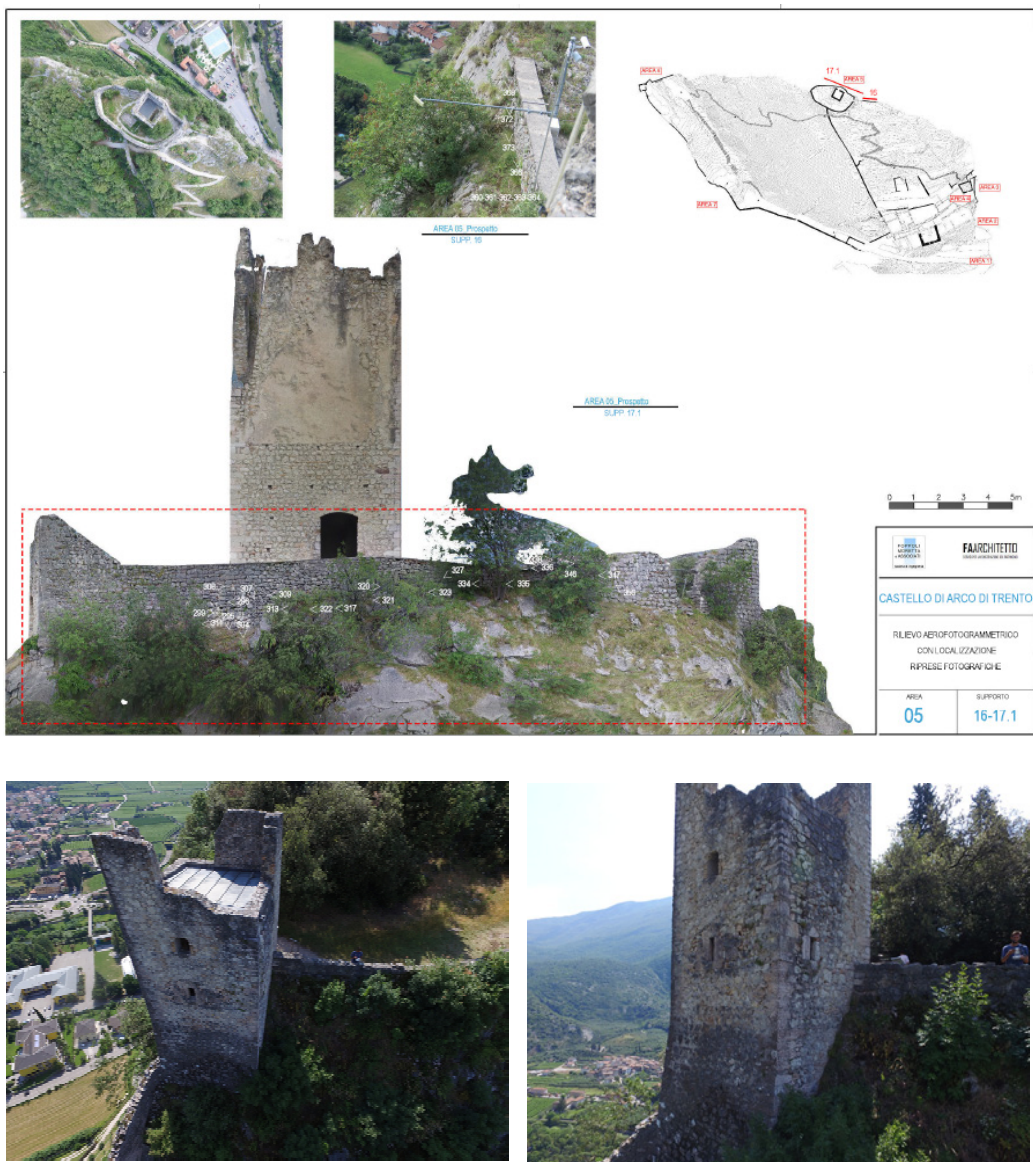
The fortress is a major tourist attraction, but its conservation status was not subjected to an overall investigation during the last two decades.

The analysis of a large and inaccessible building such as Arco Castle required methodologies to carry out surface evaluation by expert technicians, to collect and record the relevant data with efficient methods, by developing analytical reports that can describe the state of conservation and define intervention priorities. Thus, inspection activities were developed, with the agreement of the Municipality and with the aim to provide an useful tool to understand and evaluate the conservation status of the castle, in order to plan and manage future conservation activities. The following activities were carried out on Arco Castle:

- Aero-photogrammetric survey with the use of a drone to obtain the photo-straighten up of the front views of the walls.
- Inspection of the external surfaces carried out with access and positioning techniques by ropes.
- Photographic documentation.
- Drawing up inspection report.
- Drawing up synoptic sketch.
- Preliminary planning and cost estimation.

Aero-photogrammetric survey with the use of a drone

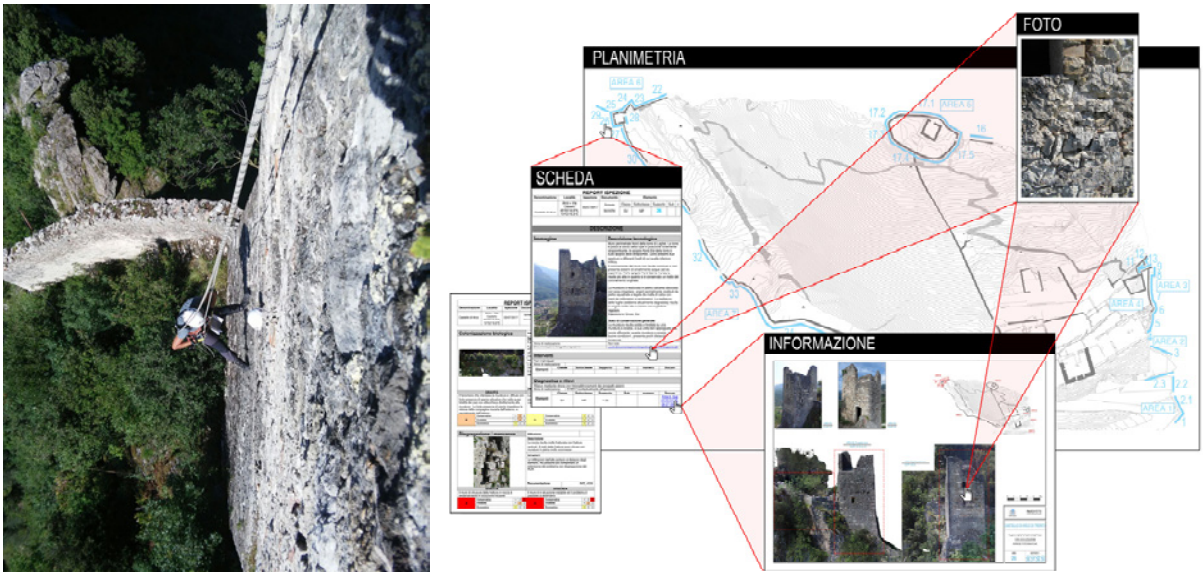
Through a drone it was possible to perform a stereoscopic photogrammetry to capture metric data of the external walls by taking couples of stereo metric frames made by two different shooting points. In this case the remote controlled drone was necessary to take the shooting, even at inaccessible points. Photos were processed using a software that interpolates the image pixels and creates a three-dimensional Point Cloud model. From the model it was possible to acquire the orthophoto of the front views.



Arco Castle: survey by drone; photo-straighten up of the walls and location of photographic shoots.

Inspection of the external surfaces of the walls

The use of access and positioning techniques by ropes was necessary in order to inspect the walls raising on the edge of the cliff, in compliance with the Italian Health & Safety Code.



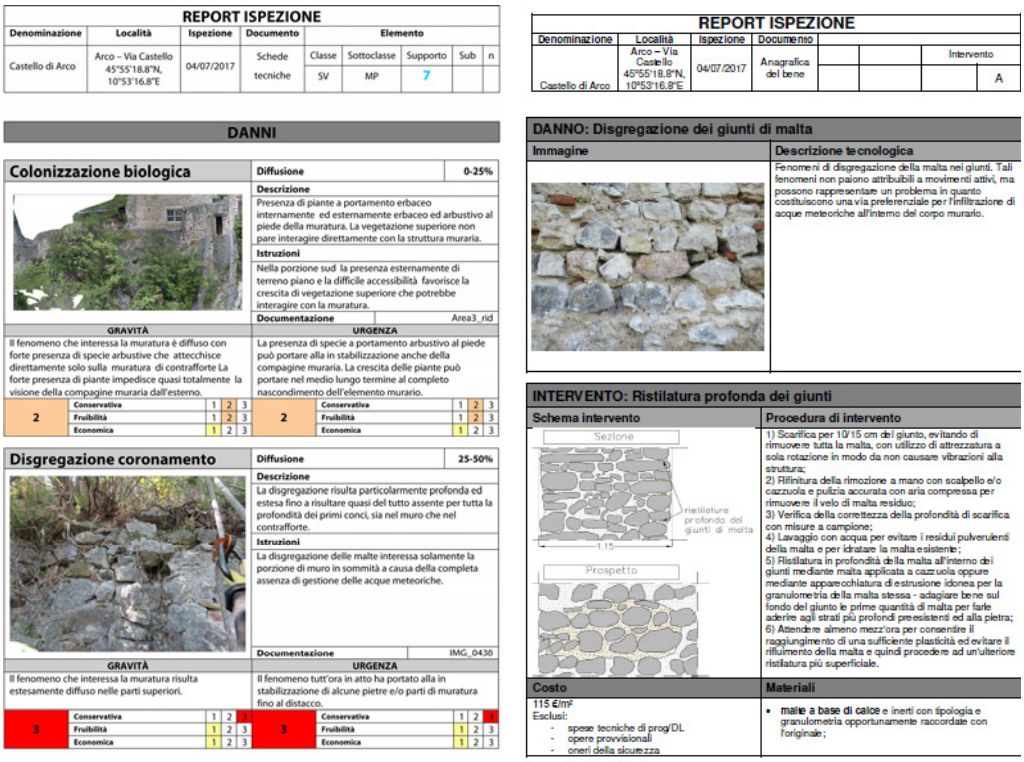
Arco Caste: inspection through ropes; report arranged in an IT support.

The proposed tool develops an analytical and expeditious data collection to provide a qualified and reasoned assessment of intervention priorities on the building. The report arranges the information analytically collected by processing forms for each technological element. It was also organized on an IT support: forms were linked to their planimetric position, to photo shoots and to the general information (artistic, historical, diagnostic). In this way the query can be done automatically, interactively, quickly and efficiently according to the sketch reported below.

Analytical inspection report

The analytical inspection report records the state of conservation and allows the following evaluation of the priorities of the intervention. Since data collection and data quality is the most qualifying primary assumption for the correct setting of any decision-making process, condition assessment methodologies were adopted. The work foresaw the drawing up of forms for each element/technological class. The forms were structured in:

- Description: a description of the conservation status and the photographic documentation.
- Interventions: the forms file the interventions already made on the asset.
- Diagnostics and surveys: the forms file the activities already performed for analysis and knowledge purposes.
- Damages: a description of the damages and mechanisms that caused the damages, by reporting also the magnitude of the damage and the urgency.
- Program: it contains the actions to prevent the expected degradations. The actions are analytically described within a table that contains all the useful data for their description and categorization. The table also allows the grouping of actions for homogeneous categories useful to optimize activities (date, mode, accessibility, operator, etc.).



REPORT ISPEZIONE

Denominazione	Località	Ispezione	Documento	Elemento				
				Classe	Sottoclasse	Supporto	Sub	n
Castello di Arco	Arco – Via Castello 45°55'18.8"N, 10°53'16.8"E	04/07/2017	Schede tecniche	SV	MP	7		

REPORT ISPEZIONE

Denominazione	Località	Ispezione	Documento				
						Intervento	
Castello di Arco	Arco – Via Castello 45°55'18.8"N, 10°53'16.8"E	04/07/2017	Anagrafica del bene				A

DANNI

Colonizzazione biologica — Diffusione: 0-25%

Descrizione: Presenza di piante a portamento erbaceo internamente ed esternamente erbaceo ed arbustivo al piede della muratura. La vegetazione superiore non pare interagire direttamente con la struttura muraria.

Istruzioni: Nella porzione sud la presenza esternamente di terreno piano e la difficile accessibilità favorisce la crescita di vegetazione superiore che potrebbe interagire con la muratura.

Documentazione: Area3_rid

GRAVITÀ			URGENZA		
2	Conservativa	1 2 3	2	Conservativa	1 2 3
	Fruibilità	1 2 3		Fruibilità	1 2 3
	Economica	1 2 3		Economica	1 2 3

Il fenomeno che interessa la muratura è diffuso con forte presenza di specie arbustive che attecchisce direttamente solo sulla muratura di contrafforte La forte presenza di piante impedisce quasi totalmente la visione della compagine muraria dall'esterno.

La presenza di specie a portamento arbustivo al piede può portare alla in stabilizzazione anche della compagine muraria. La crescita delle piante può portare nel medio lungo termine al completo nascondimento dell'elemento murario.

Disgregazione coronamento — Diffusione: 25-50%

Descrizione: La disgregazione risulta particolarmente profonda ed estesa fino a risultare quasi del tutto assente per tutta la profondità dei primi conci, sia nel muro che nel contrafforte.

Istruzioni: La disgregazione delle malte interessa solamente la porzione di muro in sommità a causa della completa assenza di gestione delle acque meteoriche.

Documentazione: IMG_0438

GRAVITÀ			URGENZA		
3	Conservativa	1 2 3	3	Conservativa	1 2 3
	Fruibilità	1 2 3		Fruibilità	1 2 3
	Economica	1 2 3		Economica	1 2 3

Il fenomeno che interessa la muratura risulta estesamente diffuso nelle parti superiori.

Il fenomeno tutt'ora in atto ha portato alla in stabilizzazione di alcune pietre e/o parti di muratura fino al distacco.

DANNO: Disgregazione dei giunti di malta

Immagine	Descrizione tecnologica
	Fenomeni di disgregazione della malta nei giunti. Tali fenomeni non paiono attribuibili a movimenti attivi, ma possono rappresentare un problema in quanto costituiscono una via preferenziale per l'infiltrazione di acque meteoriche all'interno del corpo murario.

INTERVENTO: Ristilatura profonda dei giunti

Schema intervento	Procedura di intervento
Sezione; ristilatura profonda dei giunti di malta; 1.15; Prospetto	1) Scarifica per 1/3/15 cm del giunto, evitando di rimuovere tutta la malta, con utilizzo di attrezzatura a sola rotazione in modo da non causare vibrazioni alla struttura; 2) Rifinitura della rimozione a mano con scalpello e/o cazzuola e pulizia accurata con aria compressa per rimuovere il velo di malta residuo; 3) Verifica della correttezza della profondità di scarifica con misure a campione; 4) Lavaggio con acqua per evitare i residui pulverulenti della malta e per idratare la malta esistente; 5) Ristilatura in profondità della malta all'interno dei giunti mediante malta applicata a cazzuola oppure mediante apparecchiatura di estrusione idonea per la granulometria della malta stessa - adagiare bene sul fondo del giunto le prime quantità di malta per farle aderire agli strati più profondi preesistenti ed alla pietra; 6) Attendere almeno mezz'ora per consentire il raggiungimento di una sufficiente plasticità ed evitare il rifluimento della malta e quindi procedere ad un'ulteriore ristilatura più superficiale.

Costo	Materiali
115 €/m² Esclusi: - spese tecniche di prog/DL - opere provvisionali - oneri della sicurezza	• malte a base di calce e inerti con tipologia e granulometria opportunamente raccordate con l'originale;

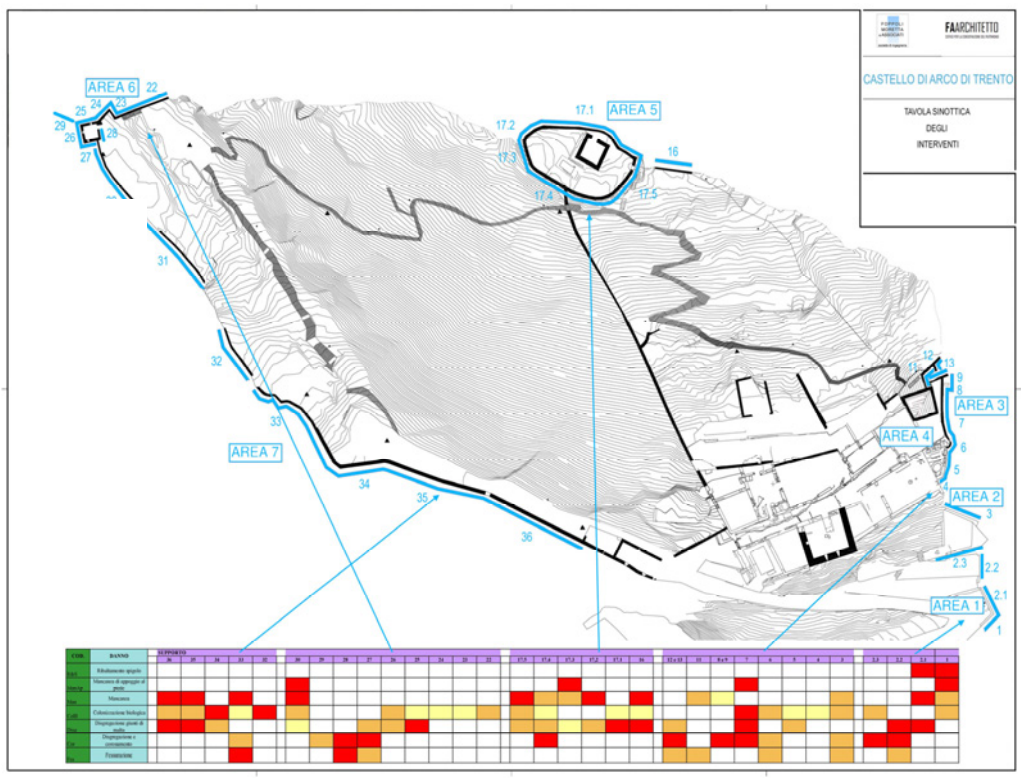
Arco Caste: excerpt of the analytical inspection report related to the damages and to the planned interventions.

Synoptic sketch

The synoptic sketch provides a global representation of the framework of urgencies and the visual location of the elements in the space through planimetric references; it also fits in with the specific vision provided by the analytical forms.

Conclusions

The report proved to be a structured database on upgradable forms. It allowed to identify the priorities for the preservation of the building and the necessary activities in an expedite and analytical way. It provided a quick and effective tool in order to support decision-making process. It ensured an effective use of small budgets, optimizing activities and reducing costs and it allowed the creation of more advanced management models and finally it promoted the eligibility of the activities, their communication and enhancement (best practice, sustainability, etc.).

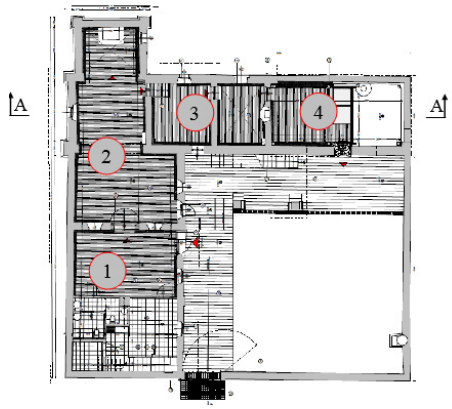
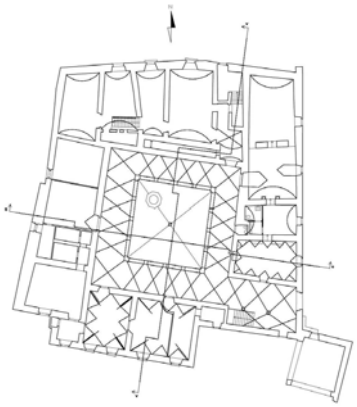


Arco Castle: example of a synoptic sketch.

CASE STUDY N. 6 - SAFETY FOR SEISMIC EVENTS - SEISMIC VULNERABILITY
Cascina Monastero in Castelseprio (Varese) and Besta Palace in Teglio (Sondrio) [Annex 18]

Description of the buildings

The data of the analyses for the evaluation of seismic vulnerability of Cascina Monastero in Castelseprio and Besta Palace in Teglio are presented in parallel, in order to elaborate a comparative assessment concerning the Level of Knowledge (LC) and the different Levels of Evaluations (LV).

Description of the building	
Cascina Monastero in Castelseprio (Varese)	**Besta Palace in Teglio (Sondrio)**
The Farmhouse Monastery is part of the wider area Castrum of Castelseprio (Province of Varese), which is located in a plain with relevant archaeological remains dated back to the IV-XVII century a.C. The whole area is listed by the UNESCO in the "Italia Langobardorum" site.  Plan of the ground floor.	Besta Palace in Teglio (Province of Sondrio) is dated back in its main structure to the first decades of the XVI century. It stands on an existing structure, possibly dated backed to the XIV century, that is partly conserved in the northern masonry.  Plan of the ground floor.
The Farmhouse Monastery of S. Giovanni is a 21.5x23.5 m complex, that was built around a central courtyard. It is composed by volumes built in different phases: 1. A rectangular 10x8 m volume, with a maximum high of approximately 8 m. 2. The Church, made of a single space divided into two spans 5 m long and 6 and 8 m wide and a 3.5x5 m apse with a cross vault that is separated by an arc-diaphragm 3. A small 5.5x8 m volume, with a maximum high of approximately 8 m., that is located next to the Church. It is characterized by an arcade with a roof standing on two external pillars. 4. A new 5.5.x9.5 m volume, that is located south of the main building (previously in state of ruin). Its structural typology is constituted of a shear walls wooden frame with still tie rods and a roof similar to the one of the main building. Finally it is important to retrieve the restoration intervention of the whole complex, operated in 2003 and 2004 (Carbonara, 2011).	The building is approximately a 38x38 m square. It is characterized by a floor partially underground and two floors above ground, that are built around a squared courtyard with two loggia orders. The ground floor has a maximum high of approximately 4 m. The ceilings are predominantly constituted of barrel vaults and cloister vaults, apart from the south-west area, where the ceilings are constituted of wooden planking. At the first floor the ceilings are made of cloister vaults in the east side and of wooden planking in the west side. The second floor presents wooden ceilings. The roof is a wooden structure with the local stone slabs "piöde" as roof covering. Two loggias (at ground and first floors) overlook the internal courtyard. They are structured with cross vaults standing on circular pillars. During the period 2009-2010, a structural consolidation of the wooden ceilings of the west wing of the building was executed (Foppoli et al., 2009).

The path to knowledge

The chapter 4 of the Italian guidelines for the assessment and reduction of the seismic hazard of the cultural heritage (D.P.C.M. 09/02/2011) defines the knowledge of the historical building as a fundamental assumption for the purpose of reliable assessment of seismic safety. Therefore, the seismic evaluation requires the execution of a specific path to knowledge directed to the identification of geometrical and structural information.

On the basis of the information and data derived from the investigations that were previously executed, the following tables report the knowledge aspects and the consequent Partial Confidence Factors (FCk), used for the definition of the Global Confidence Factor (FC).

The path to knowledge

Cascina Monastero in Castelseprio (Varese)

The confidence factor is **1.26**.

Aspects of knowledge	Specifications	Availability	FC_k
Geometrical survey	Geometrical survey	Provided by the Soprintendenza	0.05
	Crack pattern	Not available	
	Deformation layout	Not available	
Historical analysis	Constructive events	Available	0.06
	Interventions XX century	Available	
Material survey and state of conservation	Wooden structures	Implemented (floors and roof)	
	Masonry vaults	Not available	
Mechanical characterisation of materials	Wood	Available	0.12
	Masonry	Not available	
Geotechnical aspects		Available	0.03
Structural monitoring		Available	0

Besta Palace in Teglio (Sondrio)

The confidence factor is **1.21**.

Aspects of knowledge	Specifications	Availability	FC_k
Geometrical survey	Geometrical survey	Provided by the Soprintendenza	0.00
	Crack pattern	Implemented	
	Deformation layout	Implemented	
Historical analysis	Constructive events	Available	0.06
	Interventions XX century	Available	
Material survey and state of conservation	Wooden structures	Implemented (floors west wing)	
	Masonry vaults	Implemented	
Mechanical characterisation of materials	Wood	Implemented (floors west wing)	0.12
	Masonry	Data from Besta Palace	
Geotechnical aspects		Available	0.03
Structural monitoring		Ongoing	0

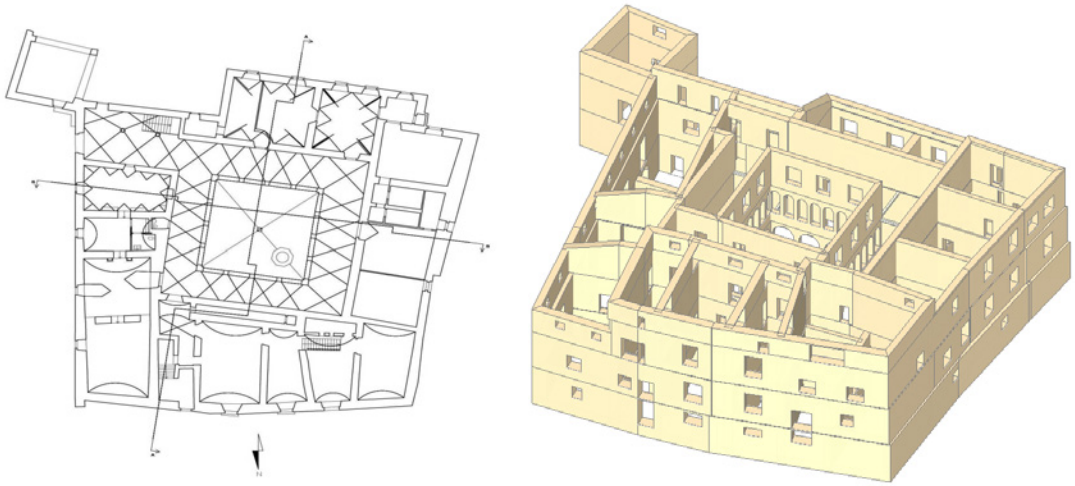
Safety evaluation

Structural modeling

On the basis of the available geometrical and mechanical data, three-dimensional numerical models representing structural elements in the space were implemented. Masonries were represented in the position identified by their medium plan, determined trough the geometrical survey.

Evaluation of the seismic vulnerability at the Level LV1

Concerning listed buildings, the specific legislation in the seismic field foresees the possibility to obtain an evaluation at a preliminary level of the seismic vulnerability of the structure, applying a simplified verification method LV1, as in the image below.



In termini di TR [anni]	**2.147**
In termini di PGA [g]	**1.281**

Evaluation of the seismic vulnerability at the Level LV1 in the Besta Palace in Teglio.

With reference to the building typology “palaces, villas and other structures with shire walls and intermediate ceilings”, the use of a simplified three-dimensional model is foreseen. It can disregard the evaluation of the rigid connections in the corners and in the intersections of horizontal diaphragms. The analysis was developed trough models managed with intermediate floors: this means that each floor receives the loads from the floor above, only on the basis of the geometric incidences of the above wall and that its structural analysis is developed regardless of other floors.

The methodology described in the Italian guidelines D.P.C.M. 09/02/2011 requires that compressive forces on each wall must be known, relating to the combination of vertical loads acting in seismic phase, in order to determine the shear strength of that wall.

The D.P.C.M. 09/02/2011, art. 5.4.2. foresees, in the cases of building typology “palaces, villas and other structures with shire walls and intermediate ceilings”, the possibility to refer to two recurrent collapse mechanisms:

- Uniform collapse, that involves the whole building.
- Collapse of one weak intermediate floor.

With reference to SLV (maximum limit of life safeguard), the building “capacity” can be represented by the ordinate of the response spectrum corresponding to the sustainable shear force.

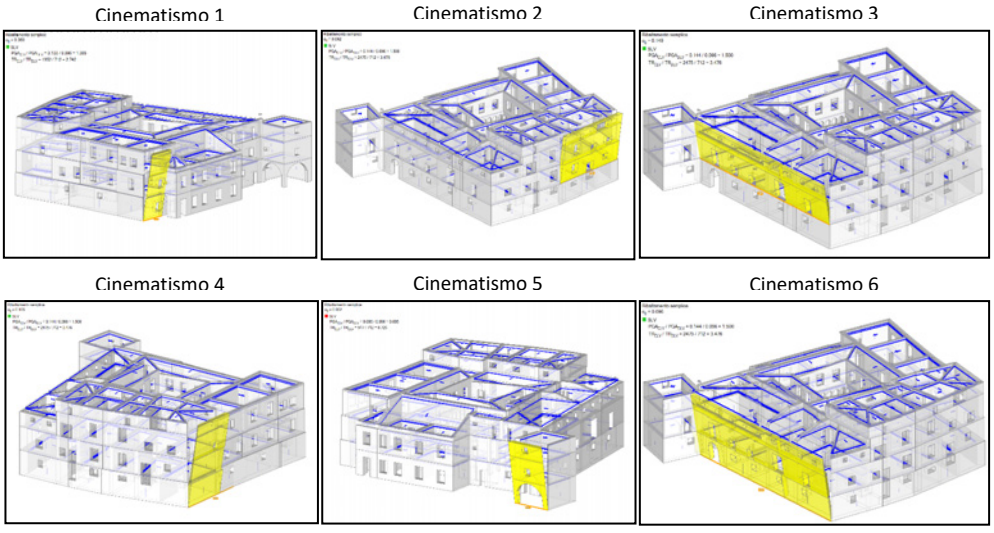
The results derived from the executed analysis LV1 are here reported.

Evaluation of the seismic vulnerability at the Level LV1	
According to the Italian guidelines D.M. 14/01/2008, the following symbology is used: SLV = Maximum limit of life safeguard (*Stato Limite di salvaguardia della Vita*) TR = Time to recovery (*Tempo di Ritorno*) ag = Maximum horizontal acceleration to the site (*accelerazione orizzontale massima al sito*) Fo = Maximum value of the amplification factor of the spectrum in horizontal acceleration (*valore massimo del fattore di amplificazione dello spettro in accelerazione orizzontale*) TC* = Start period of the constant speed portion of the spectrum in horizontal acceleration (*periodo di inizio del tratto a velocità costante dello spettro in accelerazione orizzontale*) TC = Start period of the constant speed portion of the spectrum (*periodo di inizio del tratto a velocità costante dello spettro*) Sd = Project spectrum (*Spettro di progetto*) PGA = Peak Ground Acceleration (*accelerazione su suolo rigido*)	
Cascina Monastero in Castelseprio (Varese)	**Besta Palace in Teglio (Sondrio)**
Level LV1 – Indicators of seismic risk: - **In terms of Peak Ground Acceleration (PGA)**: (PGA, CLV / PGA, DLV)= 0.041 g / 0.042 g = **0.976 < 1** - **In terms of TR**: (TR, CLV / TR, DLV) = 662 years / 712 years = **0.930 < 1** (TR, CLV / TR, DLV)^{0,41} = (662 years / 712 years)^{0,41} = **0.970 < 1** - **In terms of V_g: 46.5 years**	Level LV1 – Indicators of seismic risk: - **In terms of Peak Ground Acceleration (PGA)**: (PGA, CLV / PGA, DLV)= 0.123 g / 0.096 g = **1.281 ≥ 1** - **In terms of TR**: (TR, CLV / TR, DLV) = 1529 years / 712 years = **2.147 ≥ 1** (TR, CLV / TR, DLV)^{0,41} = (1529 years / 712 years)^{0,41} = **1.367 ≥ 1** - **In terms of Vg: 107.4 years**

Evaluation of the seismic vulnerability at the Level LV2

In accordance with the Italian guideline DPCM 09/02/2011 and with the instruction Circ. 02/01/2009 n. 617, also an evaluation of seismic vulnerability at the Level LV2 has to be developed. This analysis allowed to highlight the parts of the structures (macroelements), that can be characterized by local collapse mechanisms out of plan, thus integrating the results obtained with the previous evaluation at level LV1.

The assessment of the local mechanisms was developed trough the "limit equilibrium analysis method", that is based on the choice of the collapse mechanism and the evaluation of the horizontal load corresponding to the mechanism activation. It is also based on the hypothesis that the collapse mechanism is due to the loss of balance of limited portions of the building, defined "macroelements" (see image below).



Cinematismo	1	2	3	4	5	6
In termini di TR [anni]	2.745	3.478	3.476	3.476	0.726	3.476
In termini di PGA [g]	1.385	1.500	1.500	1.500	0.885	1.500

Evaluation of the seismic vulnerability at the Level LV2 in the Besta Palace in Teglio: analysis of the local collapse mechanisms.

Since the east wing of the Besta Palace in Teglio is characterized by several masonry vaults and complete information related to them were already available, a verification with the limit analysis method was carried out also taking into account the widest and most significant barrel vault. Considering the horizontal loads induced by the vault after a seismic event upon the perimeter walls and the ties, an evaluation of the load increase was executed. The adequacy of the ties to contrast the failure thrust of the vault was verified. Anyway, the activation of the collapse kinematic mechanism of the vault occurs before the activation of the wall overturning mechanism.
Following the results derived from the LV2 analysis.

Evaluation of the seismic vulnerability at the Level LV2

According to the Italian guidelines D.M. 14/01/2008, the following symbology is used:

SLV = Maximum limit of life safeguard (*Stato Limite di salvaguardia della Vita*)
TR = Time to recovery (*Tempo di Ritorno*)
ag = Maximum horizontal acceleration to the site (*accelerazione orizzontale massima al sito*)
Fo = Maximum value of the amplification factor of the spectrum in horizontal acceleration (*valore massimo del fattore di amplificazione dello spettro in accelerazione orizzontale*)
TC* = Start period of the constant speed portion of the spectrum in horizontal acceleration (*periodo di inizio del tratto a velocità costante dello spettro in accelerazione orizzontale*)
TC = Start period of the constant speed portion of the spectrum (*periodo di inizio del tratto a velocità costante dello spettro*)
Sd = Project spectrum (*Spettro di progetto*)
PGA = Peak Ground Acceleration (*accelerazione su suolo rigido*)

Cascina Monastero in Castelseprio (Varese)

Level LV2 – Indicators of seismic risk:
- **In terms of Peak Ground Acceleration (PGA)**:
  (PGA, CLV / PGA, DLV)= 0.051 g / 0.042 g = **1.214 > 1**
- **In terms of TR**:
  (TR, CLV / TR, DLV) = 1593 years / 712 years = **2.237 > 1**
  $(TR, CLV / TR, DLV)^{0,41}$ = (662 years / 712 years)^{0,41} = **1.391 > 1**
- **In terms of V_g: 111.90 years**

OVERTURNING MECHANISM	IRS_{PGA}	IRS_{TR}
a) West global façade:		
hinge 1 (G.F.)	1.310	3.096
hinge 2 (F.1)	1.357	3.476
b) North partial façade:		
hinge 1 (G.F.)	1.357	3.476
c) East partial façade:		
hinge 1 (G.F.)	1.357	3.476
d) South partial façade:		
hinge 1 (G.F.)	**1.214**	**2.237**
hinge 2 (F.1)	1.357	3.476
e) South partial façade:		
hinge 1 (G.F.)	1.357	3.476
f) West angle:		
hinge 1 (F.1.)	1.357	3.476

Since, besides the main structure built in masonry, a new

Besta Palace in Teglio (Sondrio)

Level LV2 – Indicators of seismic risk:
- **In terms of Peak Ground Acceleration (PGA)**:
  (PGA, CLV / PGA, DLV)= 0.085 g / 0.096 g = **0.885 ≤ 1**
- **In terms of TR**:
  (TR, CLV / TR, DLV) = 517 years / 712 years = **0.726 ≤ 1**
  $(TR, CLV / TR, DLV)^{0,41}$ = (517 years / 712 years)^{0,41} = **0.877 ≤ 1**
- **In terms of V_g: 36.3 years**

OVERTURNING MECHANISM	IRS_{PGA}	IRS_{TR}
a) East global façade:		
hinge 1 (G.F.)	> 1.500	> 3.476
hinge 2 (F.1)	> 1.500	> 3.476
hinge 3 (F.2)	> 1.500	> 3.476
b) North partial façade:		
hinge 1 (G.F.)	1.323	2.374
hinge 2 (F.1)	> 1.500	> 3.476
hinge 3 (F.2)	> 1.500	> 3.476
hinge 4 (F.3)	> 1.500	> 3.476
c) West partial façade:		
hinge 1 (G.F.)	> 1.500	> 3.476
hinge 2 (F.1)	> 1.500	> 3.476
hinge 3 (F.2)	> 1.500	> 3.476
d) South-West partial façade:		
hinge 1 (G.F.)	> 1.500	> 3.476
hinge 2 (F.1)	> 1.500	> 3.476
hinge 3 (F.2)	> 1.500	> 3.476

volume with a wooden frame is present, also a separated evaluation of it was conducted. The evaluation of the structural safety was developed through a linear analysis. The safety verifications were conducted both for statics conditions and seismic conditions. Following the minimum safety factors (F.S.), obtained from the combinations of load and the different analyses, defined as the relation between the project resistance of the considered element and the maximum project action acting on it. The calculation provided the following safety factors (F.S.):

Element	Analysis	F.S.
Wooden volume	Statics	**1.09**
	Seismic	**2.27**

Consequently, the result of the seismic risk evaluation on the new wooden volume is 2.27.

e) South-East façade:		
hinge 1 (G.F:)	**0.885**	**0.726**
hinge 2 (P.1)	> 1.500	> 3.476
hinge 3 (P.2)	> 1.500	> 3.476
f) East partial façade:		
hinge 1 (G.F.)	> 1.500	> 3.476
hinge 2 (F.1)	> 1.500	> 3.476
hinge 3 (F.2)	> 1.500	> 3.476
g) South façade loggia:		
hinge 3 (F.2)	> 1.500	> 3.476
h) North façade loggia:		
hinge 3 (F.2)	> 1.500	> 3.476
i) West façade loggia:		
hinge 3 (F.2)	> 1.500	> 3.476
l) East façade loggia:		
hinge 3 (F.2)	> 1.500	> 3.476
m) South-East angle:		
hinge 3 (F.2)	> 1.500	> 3.476

Conclusions

The seismic risk indicators related to the palaces were calculated trough two different Evaluation Levels (LV), whose results are reported below.

Evaluation of the seismic vulnerability at the Level LV1 and LV2

Cascina Monastero in Castelseprio (Varese)

Level	I_S
LV1	**0.930**
LV2	**2.237**

Consequently, the result of the seismic risk evaluation of the palace is considered the minimum of these values:

I_S = 0.930.

Besta Palace in Teglio (Sondrio)

Level	I_S
LV1	**2.147**
LV2	**0.726**

Consequently, the result of the seismic risk evaluation of the palace is considered the minimum of these values:

I_S = 0.726

Comparing the obtained results with the two different Evaluation Levels, it is possible to deduce as follows.
Concerning the evaluation of the level LV1, in relation to the limited seismic grade of the areas (area 4 for Castelseprio and area 3 for Teglio), the buildings present a seismic risk indicator adequate in the case of the Besta Palace and substantially adequate in the case of the Cascina Monastero (in terms of time to recovery). To be noticed that in 2003-2004 the Cascina Monastero was subjected to a restoration and a complex consolidation that, although realized before the current seismic code came into effect, improved the connections of the walls and the strengthening of the intermediate floors, according to the best practices. In this way the building became an organism resistant to earthquakes.
Besides, due to the limited available Level of Knowledge (LC), a high Confidence Factor (FC) was applied. This factor causes a reduction of the mechanical characteristics of the masonry. In the case of the Cascina Monastero, the execution of an in-depth diagnostic campaign, completed with the necessary instrumental

tests, would bring to the application of a lower FC and consequently it would bring to the increase of the Is value.

Concerning the verification of the level LV2, the Cascina Monastero's convex plan layout, its limited intermediate floors dimensions and the already mentioned presence of connections and strengthening interventions prevent the development of local kinematic mechanisms, that could be potentially activated in a seismic field. Instead, in the case of the Besta Palace, the presence of some volumes located outside the main building allows the development of local kinematic mechanisms with $I_s < 1$.

Finally, in relation to the value of the seismic risk indicator, it is important to highlight that the current tendency of the administrative practice foresees that, in the context of works for seismic improvement, this indicator can be considered acceptable if $I_s \geq 0,6 \div 0,65$[1].

[1] Decree by the Civil Protection Department "Contributions for interventions of seismic risk prevention" OPCM 4007/2012, art.9 comma 4: 60% - Decrees linked to the earthquake happened in the Emilia Romagna Region in 2012: = 60% - Decrees linked to the earthquake happened in the Abruzzo Region in 2009: =60% - Delibera CIPE n.143/2006 (DGR1141/2007) = 65%.

CASE STUDY N. 7 - SAFETY FOR STRUCTURAL HAZARD - MONITORING
S. Maria Church at Lovero (Sondrio) [Annex 19]

Description of the building

The parish church of S. Maria delle Grazie in Lovero (SO) was built in 1596 and became a parish church only in 1830. In 1895, a considerable enlargement project took place which involved the extension of a bay of the nave, with the consequent demolition of the original façade and the construction of the current façade.
The building presents a Latin cross plan with a single nave and apse. The nave is covered by a barrel vault with lunettes and is divided into three bays with side chapels placed between extensive buttresses. At the intersection of the nave and the transept rises an octagonal-shaped tiburio. A sacristy to the south and a bell tower next to the north-west elevation are adjacent to the church.
The vertical structures of the building are made of stone masonry and lime mortar, externally plastered except for the upstream side. The interior walls are ornamented with frescoes and stuccos decorations. The roof presents a wooden structure and a covering of local stone slabs (piöde).

Inspection and survey of the crack pattern

The visual inspection of the structure and the survey of the cracking pattern were carried out with methods similar to the other case studies previously described. In addition to the representation of the cracks (plants and elevations), a structural inspection report was drawn up where all the individual cracks were coded and identified with photograph, description of the width, gravity, urgency and correspondence with other cracks.
The walls of the church are affected by a complex crack pattern, as it is possible to see in the image below.

S. Maria Church in Lovero displays a wide crack pattern. It was installed a structural monitoring system.

The main cracks affect symmetrically the two side façades at the second bay and their development begins just above the level of the floor with a sub-vertical pattern, then crosses the ogival window and continues on the upper part of the side wall of the hall. They are connected to each other through a crack developing along the corner formed between the arch and the vaulted barrel of the principal nave. These cracks have a centimetric opening which enlarges moving upwards.
The cracking phenomenon is still evolving; in 2015 detachments of small portions of plaster were detected at the central crack of the vault. Moreover, the crack presented in the North façade was reactivated again after the restoration work on the plasterwork carried out at the end of the nineties.
For this reason, in agreement with the parish owner, the subsequent analyses were carried out.

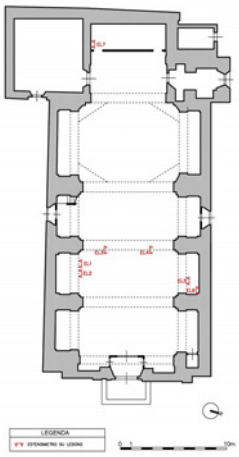
Structural monitoring

To monitor the evolution of the cracks described above, 7 strain gauges were installed in order to allow the control of the opening variation of the cracks. The monitoring was performed on a monthly basis together with measurements of temperature changes.

The strain gauges on the cracks have revealed variations of opening inversely proportional to the variations in the temperature, thus indicating that the increase of the temperature causes the closing of the cracks and vice versa, as usually noticed during the monitoring of crack phenomena.

The correlation between the thermal variations and the crack opening variations was analyzed by determining (by means of linear regression, calculated with the method of least squares) the relative coefficients. Furthermore, the annual trend was estimated by correcting the data collected by temperature influence. The values were determined on the basis of data collected in years 2015-2017.

Temperature / Base	Trend (2015-2017) [mm/ year]
Δ T	(balanced)
EL1	0,027,
EL2	0,005
EL3	0,064
EL4	0,072
EL5	0,0022
EL6	0,048
EL7	0,028



Lay-out of the monitoring and qualitative evaluation of the trend.

From the analysis of the data it can be inferred that:

- The instruments EL1 - EL2 - EL5 - EL7 show positive moments, but so small in entity to be not relevant in relation to the accuracy of the data available. The analysis of the monitoring data has also demonstrated the reduction of the movements reported in the first years by EL2 and EL6 .
- The instruments EL3 e EL4 present a behavior strongly correlated with the temperature variation since the passing crack behaves as a thermal joint, however presenting a residual trend on the order of 0.064-0.072 mm/year.

Diagnostic investigations (soil-foundations)

A specific geological and geotechnical survey was carried out on site through the execution of 6 dynamic cone penetration tests (D.C.P.T.). In order to analyze the soil-foundation correlation, 4 little additional excavations were made (2 on the south wall, 1 on the main façade and 1 on the north wall).

The results highlighted the substantial homogeneity of the geometry of the foundational structure of the building, which presents on the external side (the inspected one), at a depth of 40-60 cm, an enlargement of 20-35 cm. The excavations reached a maximum depth of 150-185 cm from the ground level without however to be able of reaching the level of the foundations, which is evidently greater.

Vulnerability assessment

The vulnerability assessment was first performed considering the static load condition and was carried out in accordance with the method provided by the D.M. 14/01/2008. It was aimed firstly at identifying the causes of the crack pattern, presented on the side walls and the vaults, and secondly at determining the safety

coefficients with respect to this phenomenon. For this reason, the analysis concerned only the portion of the church affected by the most relevant phenomenon, that is between the main façade and the apse arch.
A structural model with finite elements has been prepared and has been used to determine the stresses transmitted to the ground under the most severe load conditions, in order to verify the load-bearing capacity of the foundations. Subsequently, the structural elements of which it is possible to predict the collapse for the loss of equilibrium of "macroelements" were analyzed, by means of local analysis methods (LV2). In particular this analysis concerned the vaults and the arches of the hall.

Analysis of foundational subsidence

The structural model allowed us to calculate the stresses in terms of loads transmitted to the ground that were subsequently used in the assessment. The safety coefficients were calculated as the ratio between design resistance and design stress response: F.S. = Rd / Ed, which give a positive result if higher than 1. In all the cases analyzed the values of F.S. are lower than 1; however, it can be noticed that the calculated values are precautional because a precautionary value has been assumed for the depth of the foundation level, not fully known by the tests carried out.

		Limit load	Design resistance	Design stress	F.S.
Foundation type	**Load condition**	**Q_{ult} [daN/cm²]**	**R_d [daN/cm²]**	**E_d [daN/cm²]**	**R_d/E_d**
Main façade	Cc 37 –ULS	1.50	0.66	2.8	**0.63**
Buttress 1	Cc 37 - ULS	3.03	1.32	4.4	**0.69**
Buttress 2	Cc 37 - ULS	2.16	0.94	3.37	**0.64**
Buttress 3	Cc 37 - ULS	2.55	1.11	3.0	**0.85**

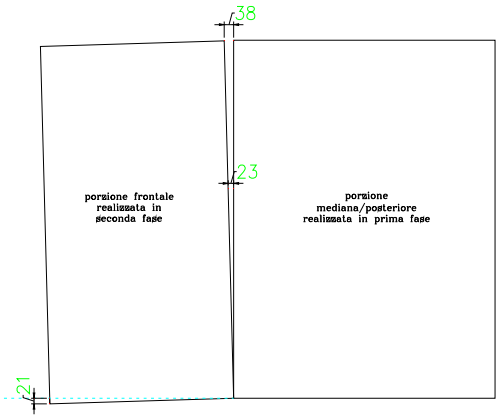
Verification of static load conditions.

It is also noticeable that the values of F.S. are not homogeneous because they are inferior in the front-median part (buttresses 1 and 2) if compared with the back part (buttress 3). The calculation of the failures presented below allows us to associate this phenomenon with the cracking pattern detected in the building.
The assessment of the load-bearing capacity of the superficial foundations refers to the development of collapse mechanisms determined by the variation of the soil resistance. The assessment is carried out on the basis of the actions taken from the three-dimensional numerical model, by adopting the approach 2 described in paragraph 6.4.2.1. of the D.M. 01/14/2008 (Structural Code for Constructions).
The estimation of the subidence induced by the first 3 buttresses was made on the basis of the values of the loads transmitted to the ground by the foundations in the most dangerous load conditions in the ELS, calculated according to the numerical model.

		Design resistance	Failure Brluand-Burbidge	Elastic settlement	Average
Foundation type	**load condition**	**q [kPa]**	**u_1 [mm]**	**u_2 [mm]**	**u_m [mm]**
Buttress 1	Cc 37 – ELS	335	34,60	31,46	**33,03**
Buttress 2	Cc 37 - ELS	257	13.42	10.25	**11.83**
Buttress 3	Cc 37 - ELS	230	9.57	6.48	**8.02**

Calculation of subsidence.

The amount of the differential settlements between the buttresses 1 and 2 (caused by the presence in the subsoil of a subsident material portion of increasing thickness towards the main façade) justify the formation of the cracks on the side walls of the church as they allow to hypothesize a rigid rotation of the first bay of the church according to the kinematic sketched in the image below. The congruence of the scheme with respect to the actual situation is confirmed by the fact that the calculated opening of the joint between the two structural portions is compatible with the cumulative width of the detected cracks.



Sketch of the displacement caused by the failure of the front portion of the Church.

Analysis of the vaulted structures

The hall is divided into 3 bays covered by barrel vaults, subdivided by underneath arches, with lunettes in correspondence of the side windows. The verifications of these structures were carried out through a limit analysis (Heyman, 1966).

Since the theory of limit analysis is developed by analyzing the plane section of an arch, the structural modeling was carried out starting from the geometrical schematizations described below:

- The vault with lunettes was represented as an arch in the plane having a thickness of 16 cm, width equal to the area between the two arches (4.52 m) and a variable width in the area of intersection with the leaves.
- The arch was modeled with a uniform thickness of 45 cm, according to the three-dimensional geometry deduced from the survey.

In the static case, F.S. is defined as the ratio between the maximum accidental load corresponding to the instability of the arch and the accidental load considered.

Structure	Load condition	F.S.
Vault	1 (p.p)	>>1
	2 (p.p.+0,5 kN/m^2 simm)	11.56
	3 (p.p.+0,5 kN/m^2 asimm)	1.618
	4 (p.p.+ 1,2 kN conc 1/4)	12.052
Arch	1 (p.p)	>>1
	2 (p.p.+0,5 kN/m^2 simm)	18.51
	3 (p.p.+0,5 kN/m^2 asimm)	20,57
	4 (.p.+ 1,2 kN conc 1/4)	19,09

Safety factors obtained from the static and seismic verification of the vaults.

The above verifications show values of F.S. ≥ 1,618> 1 and therefore they comply with the standard parameters concerning the hypothesized accidental loads.

The verification of the reinforcing tie-rods was carried out assuming for the steel, tensile strength f_t = 200 N/mm^2.
Tension on the reinforcing tie-rods:
N (kN) = 51.18 + 16.58= 67.76 kN A (mm^2) = 705 □ (N/mm^2) = 96 < 200.0
Also this aspect is verified.

LV1 level seismic vulnerability analysis

The assessment of seismic vulnerability at LV1 level provided by the DPCM 09/02/2011 allows the evaluation of the seismic action at SLV through simplified methods, based on a limited number of geometric and mechanical parameters or qualitative data (visual inspection, individuation of the constructive characteristics, stratigraphic survey).
The reference model for the typology of "churches, places of worship and other structures with large rooms, without intermediate floors " is defined at point 5.4.3. of the DPCM directive 09/12/2011. The methodology analyses 28 damage mechanisms, matched with the different macroelements that may be present in a church. With reference to the vulnerability assessment, it is necessary to detect those typological and constructive details that play a fundamental role in the seismic response of the building. In particular, indicators of vulnerability and anti-seismic protection are considered. The seismic behaviour of the global building is represented, on a statistical basis, by an vulnerability indicator, variable between 0 and 1, which is defined as a weighted average of the behaviour of the different parts of the church.
Through an appropriate correlation between the intensity and the peak ground acceleration, it was possible to define a direct correlation between the seismic input associated with the different limit states and the detected vulnerability. This makes it possible to calculate, for each church, the values of ground acceleration, corresponding to the damage limit state (DLS) and the life-safeguard limit state (LLS).

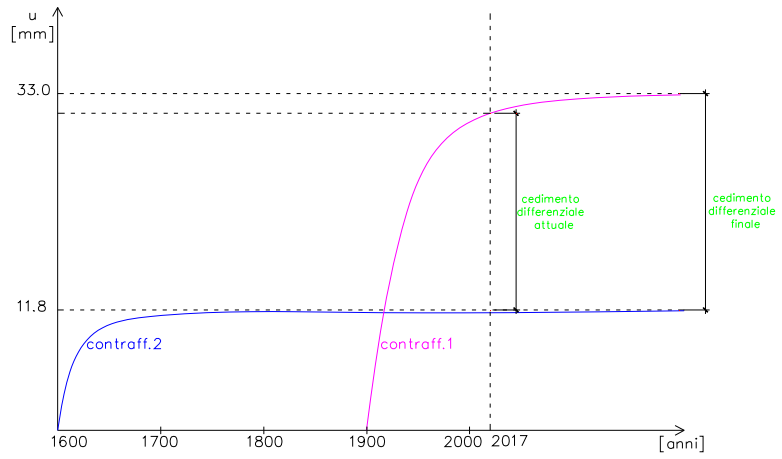
Seismic safety indicator	$I_{S,SLV}$	**5.18**	
Acceleration factor	$f_{a,SLV}$	**2.230**	
Nominal life	Vn	**258.9**	years

Results of the analysis LV1.

Conclusions

The church of S. Maria delle Grazie in Lovero presents a relevant crack pattern, in particular at the side walls between the first and the second bay on both sides, which also affects the vault of the hall. The historical analysis has shown that the first bay and the main façade constitute an extension (built in 1895) with respect to the original construction of the church (dating back to 1596). The diagnostic results have revealed that the geometry of the foundations is substantially uniform throughout the church; the geotechnical survey made it possible to highlight the marked heterogeneity of the foundation soil due to the presence of a sandy material portion at the front of the church.
The structural modeling, the subsequent verifications, and the calculation of the expected subsidence of the foundation structures demonstrate that the existing crack pattern is closely related to the differential subsidences developed due to the described geotechnical characteristics of the site. As in granular soil with water table at very deep depth, the foundational subsidence progresses rapidly in the first period of the application of the load (i.e. the construction of the building) and tends to shrink asymptotically over time, the phenomenon in progress can be qualitatively represented by the graph plotted above, which represents the evolution over time of the cracks (in mm) of the buttress 1 (front) and of the buttress 2 (middle part).
The expected subsidence of the original part of the church (older than 400 years) can now be considered exhausted, while for the part of the main façade (older than 120 years) it is possible to assume that the settlements have been developed at present for over 90% of the total. It is reasonable to expect a further

increase in subsidence of the façade, which should be limited to a few mm. This forecest is consistent with the data provided by the monitoring system which has effectively highlighted the fact that the cracking phenomena are still active, but with a low annual trend (maximum values lower than 0.08 mm / year).
On the basis of these considerations, structural problems that are significant for the building are not expected in the short or long term. The building tends over time to find a state of equilibrium with foundation subsidence. However it cannot be excluded that such failures cause further small detachments of portions of plaster and decorative elements, as occurred in the recent past.



Graph of the deformation over time.

MEETINGS

Meetings between all the partners and local stakeholders in the Italian context.			
Date	**Place**	**Participants**	**Aim**
24-27 May 2016	Province of Milan, Province of Monza and Brianza, Province of Sondrio (IT)	- PI1: Politecnico di Milano. - PI2: University of Leuven. - PI3: Technische Universiteit Delft. - PI4: Uppsala University. - PI5: FmeA. - AP7: Monumentenwacht Flanders. - AP8: Consortium Royal Villa and Park of Monza.	General meeting among all the partners. On this occasion, the programme included site visits to historical buildings, which constitute case studies analyzed by both PI1 – ABC Department, Politecnico di Milano and PI5 – Foppoli Moretta e Associati consulting engineers, with the involvement of local stakeholders.
Meetings between PI1 – ABC Department, Politecnico di Milano, PI5 – FmeA, associates partners and local stakeholders involved in order to start action learning activities in the Italian context.			
Date	**Place**	**Participants**	**Aim**
9 November 2015	Milan (IT)	- PI1: Politecnico di Milano. - PI5: FMeA. - AP8: Consortium Royal Villa and Park of Monza.	
26 November 2015	Milan (IT)	- PI1: Politecnico di Milano. - PI5: FmeA. - AP8: Consortium Royal Villa and Park of Monza. - AP9: Na.Gest. - AP10: Assimpredil ANCE Milano, Monza e Lodi.	The meeting was aimed at explaining the work plan, the objectives, task and activities related to WP2, WP5 and WP6 (where the associates partners have an active role).
30 November 2015	Milan (IT)	- PI1: Politecnico di Milano. - Fondazione Cariplo.	Involvement of Fondazione Cariplo in the evaluation of previous experiences in order to develop replicable models for granting heritage activities (Valtellina and Monza and Brianza Cultural Districts).
9 February 2016	Sulbiate, Province of Monza and Brianza (IT)	- PI1: Politecnico di Milano. - AP8: Consortium Royal Villa and Park of Monza. - Municipality of Sulbiate: A. Crespi (Major of Sulbiate), M. G. Riva (Head of public works office). - Impresa Fantin: F. Fantin.	
10 February 2016	Biassono, Province of Monza and Brianza (IT)	- PI1: Politecnico di Milano. - AP8: Consortium Royal Villa and Park of Monza. - Municipality of Biassono: M. Cazzaniga (Head of public service office), M. Paleari (Head of cultural office).	

		- Impresa I.M.G.: M. Maffioli.	
11 February 2016	Consortium Royal Villa and Park of Monza, Monza (IT)	- PI1: Politecnico di Milano. - AP8: Consortium Royal Villa and Park of Monza.	
16 February 2016	Usmate con Velate, Province of Monza and Brianza (IT)	- PI1: Politecnico di Milano. - AP8: Consortium Royal Villa and Park of Monza. - Municipality of Usmate Velate: E. Riva (Major of Usmate), A. Valli (Head of public works office).	
17 February 2016	Italiana Costruzioni S.p.A., Milan (IT)	- PI1: Politecnico di Milano. - AP9: Na.Gest.	
22 February 2016	Royal Villa, Monza (IT)	- PI1: Politecnico di Milano. - AP9: Na.Gest.	
26 February 2016	Royal Villa, Monza (IT)	- PI1: Politecnico di Milano. - E. Zanotti (restorer).	
2 March 2016	Royal Villa, Monza (IT)	- PI1: Politecnico di Milano. - AP8: Consortium Royal Villa and Park of Monza. - AP9: Na.Gest.	
16 March 2016	Biassono and Sulbiate, Province of Monza and Brianza (IT)	- PI1: Politecnico di Milano. - AP8: Consortium Royal Villa and Park of Monza. - Municipality of Sulbiate: A. Crespi (Major of Sulbiate), M. G. Riva (Head of public works office). - Municipality of Biassono: M. Cazzaniga (Head of public works office).	
30 March 2016	Royal Villa, Monza (IT)	- PI1: Politecnico di Milano. - AP8: Consortium Royal Villa and Park of Monza. - AP9: Na.Gest.	
6 April 2016	Royal Villa, Monza (IT)	- PI1: Politecnico di Milano. - AP9: Na.Gest.	
20 April 2016	Consortium Royal Villa and Park of Monza, Monza (IT)	- PI1: Politecnico di Milano. - AP8: Consortium Royal Villa and Park of Monza.	
26 April 2016	Italiana Costruzioni S.p.A., Milan (IT)	- PI1: Politecnico di Milano. - AP8: Consortium Royal Villa and Park of Monza. - AP9: Na.Gest. - Team System: E. Benatti. - Natisoft: A. Mongelli.	
3 May 2016	Royal Villa, Monza	- AP8: Consortium Royal Villa and	

	(IT)	Park of Monza. - AP9: Na.Gest.	
10 May 2016	Milan (IT)	- PI1: Politecnico di Milano. - AP8: Consortium Royal Villa and Park of Monza.	
11 May 2016	Sulbiate, Province of Monza and Brianza (IT)	- PI1: Politecnico di Milano. - AP8: Consortium Royal Villa and Park of Monza. - Municipality of Sulbiate: A. Crespi (Major of Sulbiate), M. G. Riva (Head of public works office).	
12 May 2016	Usmate con Velate, Province of Monza and Brianza (IT)	- PI1: Politecnico di Milano. - AP8: Consortium Royal Villa and Park of Monza. - Municipality of Usmate con Velate: A. Valli (Head of Public works office).	
20 June 2016	Italiana Costruzioni S.p.A., Milan (IT)	- PI1: Politecnico di Milano. - AP8: Consortium Royal Villa and Park of Monza. - AP9: Na.Gest.	
22 June 2016	Royal Villa, Monza (IT)	- PI1: Politecnico di Milano. - AP9: Na.Gest.	
12 July 2016	Royal Villa, Monza (IT)	- PI1: Politecnico di Milano. - AP9: Na.Gest.	
15 July 2016	Consortium Royal Villa and Park of Monza, Monza (IT)	- PI1: Politecnico di Milano. - AP8: Consortium Royal Villa and Park of Monza.	
19 July 2016	Biassono, Province of Monza and Brianza (IT)	- PI1: Politecnico di Milano. - AP8: Consortium Royal Villa and Park of Monza. - Municipality of Biassono: M. Cazzaniga (Head of public service office), M. Paleari (Head of cultural office). - Impresa I.M.G.: M. Maffioli.	
27 July 2016	Usmate con Velate, Province of Monza and Brianza (IT)	- PI1: Politecnico di Milano. - AP8: Consortium Royal Villa and Park of Monza. - Municipality of Usmate Velate: E. Riva (Major of Usmate), A. Valli (Head of public works office).	
29 July 2016	Sulbiate, Province of Monza and Brianza (IT)	- PI1: Politecnico di Milano. - AP8: Consortium Royal Villa and Park of Monza. - Municipality of Sulbiate: A.	

		Crespi (Major of Sulbiate), M. G. Riva (Head of public works office).	
10 October 2016	Biassono, Province of Monza and Brianza (IT)	- PI1: Politecnico di Milano. - Municipality of Biassono: L. Casiraghi (Major of Biassono), M. Cazzaniga (Head of public service office), M. Paleari (Head of cultural office). - Impresa I.M.G.: M. Maffioli. - Como next: F. Arcioni.	
23 August 2016	Royal Villa, Monza (IT)	- PI1: Politecnico di Milano. - AP9: Na.Gest. - Team System: E. Benatti.	
Several	Monza, Province of Monza and Brianza (IT)	- PI1: Politecnico di Milano. - Monza and Brianza Cultural Districts.	Several operative meetings with the partners of the Monza and Brianza Cultural District (private and public owners, restoration companies...) in order to introduce action learning in the follow-up of the District actions.

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ANNEX 1

CASE STUDY N. 1: ROYAL VILLA AND PARK OF MONZA

Contribution presented within the International Conference "Preventive Conservation in Historic Houses and Palace-Museums: Assessment Methodologies and Applications".The conference was organized by Le Réseau des Résidences Royales Européennes et le Château de Versailles and was held at the Palace of Versailles from 29 November to 1 December 2017.

Round table n° 1 : Preventive conservation and works in historic houses

Speaker: Rossella Moioli

Preventive Conservation in Monza Royal Villa: strategies and tools for a long term planning

Fig. 1

Fig. 2

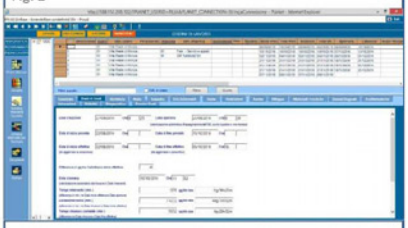


Fig. 1. Inspections carried out according to the Conservation Plan
Fig. 2. A screenshot of the Conservation Plan

S. DELLA TORRE (ed.), *La conservazione programmata del patrimonio storico- architettonico*, Guerini, 2003

The Royal Villa in Monza is an Austrian Imperial residence built in 1780-83, designed by the architect Giuseppe Piermarini, and it is surrounded by a huge park which includes several historic buildings. In following decades the Villa was completed end enriched under the rule of Napoleon I and of the Savoia dynasty.
The Villa is a relevant example of Neoclassicism style and its interiors are characterized by decorations carried out from the end of XVIII to the end of XIX century. It has been abandoned for many decades and in 2014 thanks to the last restoration the Villa has been opened permanently.
It is an interesting case study under different points of view: complexity of the conservation issues; preventive and planned conservation approach adopted for the management activities; dedicated information systems for facility and property management; private-public partnership and integration of conservation and valorisation.

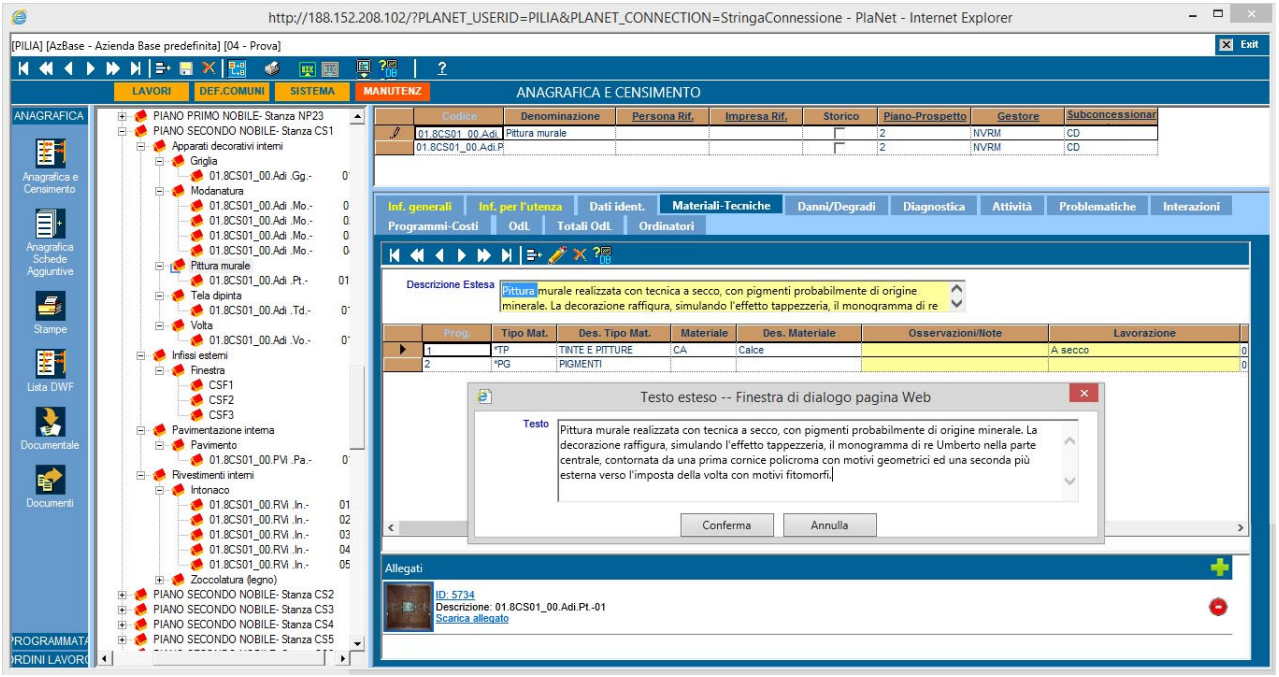
The contribution focuses on the drawing up of the Conservation Plan as a tool for a long term conservation, including risk assessment, based on the analysis of the interaction of the building, the interiors and the various hazards. The topic of relationships between historic furniture, decorations, collections, and the building has a central role in the understanding of deterioration mechanisms, and in the evaluation of risk assessment and in the management of conservation activities. The aim is to demonstrate that it is useful for the management of the relational nexus among environment, conservation conditions of the building and interior decorations and collections.
The tool adopted is a relational database, expressly studied for the implementation to complex historic buildings of a correct conservation methodology. The database has been populated first with a lot of data coming from the as built reports of the conservation works ended in 2014, then with the report of the general inspections carried out in summer 2016.
At least in Italian context, this implementation of planned inspections, small repairs, risk factors considered in facility managament, is quite innovative.
This action research has been implemented in the frame of two projects: Monza and Brianza Cultural District and JPI Heritage Plus project CHANGES (Cultural heritage Activities: New Goals and benefits for Economy and Society). Thus it has been possible for the authors to participate in the whole process: since the restoration works to the first monitoring/control activities.
The expected results of this ongoing case are: optimization of data collection, effectiveness of prevention and evaluation of costs in a long term perspective, integration between conservation and public fruition.

Acknowledgements: Nuova Villa Reale Monza s.p.a.; Na.Gest. s.p.a.; Consorzio Villa Reale e Parco di Monza; Fondazione Cariplo; Provincia di Monza e Brianza

ANNEX 2

CASE STUDY N. 1: ROYAL VILLA AND PARK OF MONZA

Technical handbook of the Royal Villa's conservation plan in the Information System Planet and one excerpt from the print version.




Piano di Conservazione
Manuale tecnico

01.8CS01_00 - PIANO SECONDO NOBILE- Stanza CS1

Descrizione

Il locale CS1 di 21,83 mq (5,8m x 3,7m) si colloca nel corpo centrale al secondo piano nobile, nell'angolo rivolto a Nord Est. Ad esso si accede dai locali adiacenti CS3 e CS2 e non direttamente dal corridoio. Il locale non presenta boiserie.

DESCRIZIONE DELLE SUPERFICI DECORATE E DEGLI ELEMENTI LIGNEI

Il vano in oggetto, inizialmente parte degli "Appartamenti di riserva" diviene "salotto" in occasione della visita dell'Imperatore di Germania tra il 1888 e il 1895 ad opera degli architetti Tarantola e Majnoni. Al locale, stanza rettangolare di piccole dimensioni che fa angolo al corpo della villa, si accede tramite due porte comunicanti con le stanze adiacenti, una sulla parete sud e una sulla parete ovest. Sul lato est si aprono tre finestre ed una sul lato nord. La sala presenta una volta a schifo in listelli lignei sfilacciati, è interamente dipinta con motivi a tappezzeria con al centro una tela rettangolare piuttosto recente contornata da una cornice lignea decorata con elementi a base carta. Attualmente la sala presenta una pavimentazione in legno, anch'essa riconducibile al periodo di riconfigurazione funzionale ad opera degli architetti sopraciati.
La destinazione d'uso della sala prevista in progetto è quella di "spazio espositivo polifunzionale". Per la sala non sono previste modifiche strutturali, o distributive interferenti con l'apparato decorativo della stessa, al di là di alcune minime introduzioni di carattere impiantistico. Si faccia riferimento in tal senso alle tavole grafiche di progetto allegate alla presente.

In questa sala si è seguito il progetto come era stato pensato , probabilmente in periodo sabaudo anche questa sala presentava tappezzerie alle pareti rilevabile per la presenza di magatelli in legno angoli dei muri. Le boiserie sempre presenti nelle altre sale, sono andate perdute.

Danni/degradi

DISTACCO

volta (stucchi e intonaci)

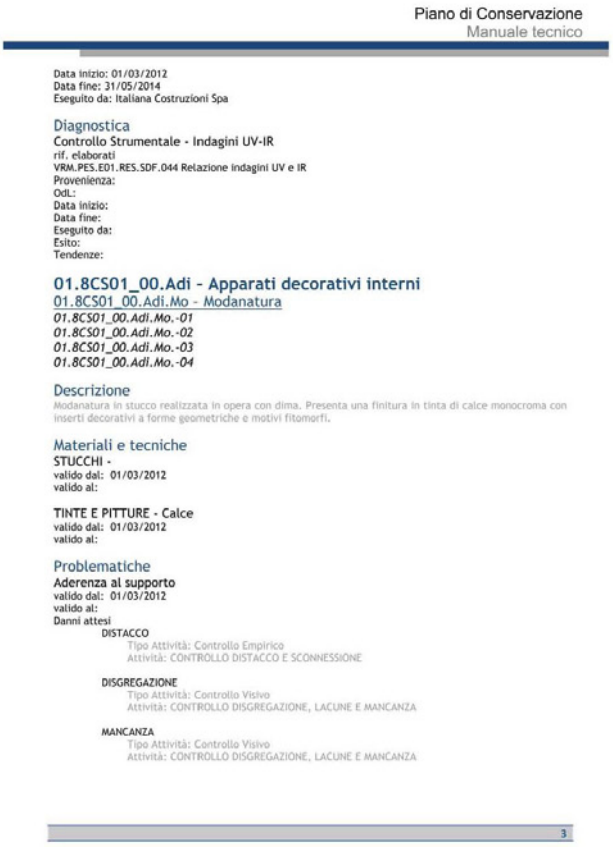
OdL di rilevazione:
Data di esecuzione:
Validità dal: 01/03/2012
Validità al: 31/05/2014
Tendenza:
Gravità:
Diffusione:

Attività

Intervento di Restauro

CORNICI LIGNEE - Consolidamento dei sollevamenti di pellicola pittorica con applicazione a pennello di emulsione acrilica (E411 al 5%-8% in alcool puro: VRM.PAB.E01.RES.PRG.200_NN. 9-27), e successivo abbassamento delle scaglie con spatola e carta siliconata;
- pulitura con sistema aeroabrasivo a pressione controllata (micro sabbiatrice 0,5 bar) ed inerte fine (garnet 200 mesh: VRM.PAB.E01.RES.PRG.200_N. 12);
- revisione del consolidamento;
- stuccatura e livellamento delle lacune con stucco con legante acrilico (modostuc: VRM.PAB.E01.RES.PRG.200_N. 13);
- integrazione pittorica con base a tempera (Maimeri extra fine) e velatura finale con colori a vernice (VRM.PAB.E01.RES.PRG.200_N. 20);
- verniciatura finale prima mano lucida applicata a pennello (Regal Retouching Varnish: VRM.PAB.E01.RES.PRG.200_N. 30) e seconda mano a spruzzo opaca (Regal Varnish Mat: VRM.PAB.E01.RES.PRG.200_N. 29);
- verniciatura della zoccolatura, a seguito della carteggiatura, con smalto sintetico (Litron Boero Ral R 1019: VRM.PAB.E01.RES.PRG.200_N. 95) con colorazione conforme alla finitura originale, al fine di avere una superficie più solida essendo la parte inferiore della boiserie più soggetta ad urti.
Provenienza:
OdL:

2


Piano di Conservazione
Manuale tecnico

Data inizio: 01/03/2012
Data fine: 31/05/2014
Eseguito da: Italiana Costruzioni Spa

Diagnostica

Controllo Strumentale - Indagini UV-IR

rif. elaborati
VRM.PES.E01.RES.SDF.044 Relazione indagini UV e IR
Provenienza:
OdL:
Data inizio:
Data fine:
Eseguito da:
Esito:
Tendenze:

01.8CS01_00.Adi - Apparati decorativi interni

01.8CS01_00.Adi.Mo - Modanatura

01.8CS01_00.Adi.Mo.-01
01.8CS01_00.Adi.Mo.-02
01.8CS01_00.Adi.Mo.-03
01.8CS01_00.Adi.Mo.-04

Descrizione

Modanatura in stucco realizzata in opera con dima. Presenta una finitura in tinta di calce monocroma con inserti decorativi a forme geometriche e motivi fitomorfi.

Materiali e tecniche

STUCCHI -
valido dal: 01/03/2012
valido al:

TINTE E PITTURE - Calce
valido dal: 01/03/2012
valido al:

Problematiche

Aderenza al supporto
valido dal: 01/03/2012
valido al:
Danni attesi

DISTACCO
Tipo Attività: Controllo Empirico
Attività: CONTROLLO DISTACCO E SCONNESSIONE

DISGREGAZIONE
Tipo Attività: Controllo Visivo
Attività: CONTROLLO DISGREGAZIONE, LACUNE E MANCANZA

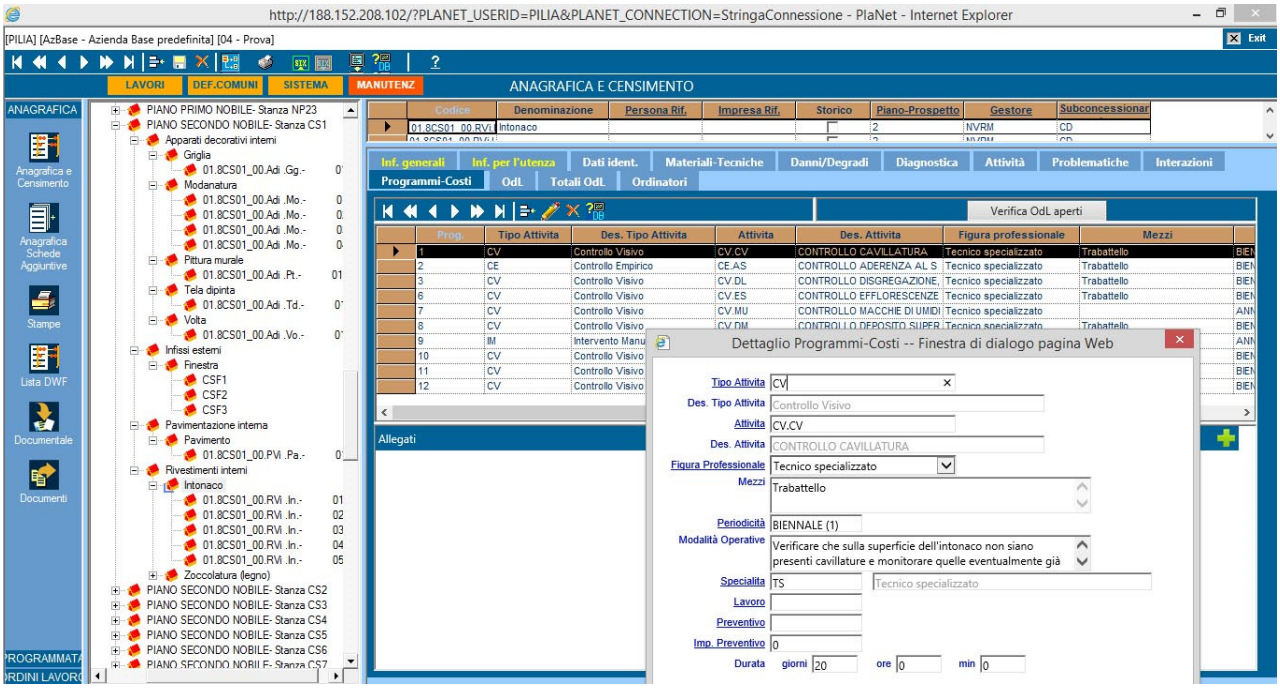
MANCANZA
Tipo Attività: Controllo Visivo
Attività: CONTROLLO DISGREGAZIONE, LACUNE E MANCANZA

3

ANNEX 3

CASE STUDY N. 1: ROYAL VILLA AND PARK OF MONZA

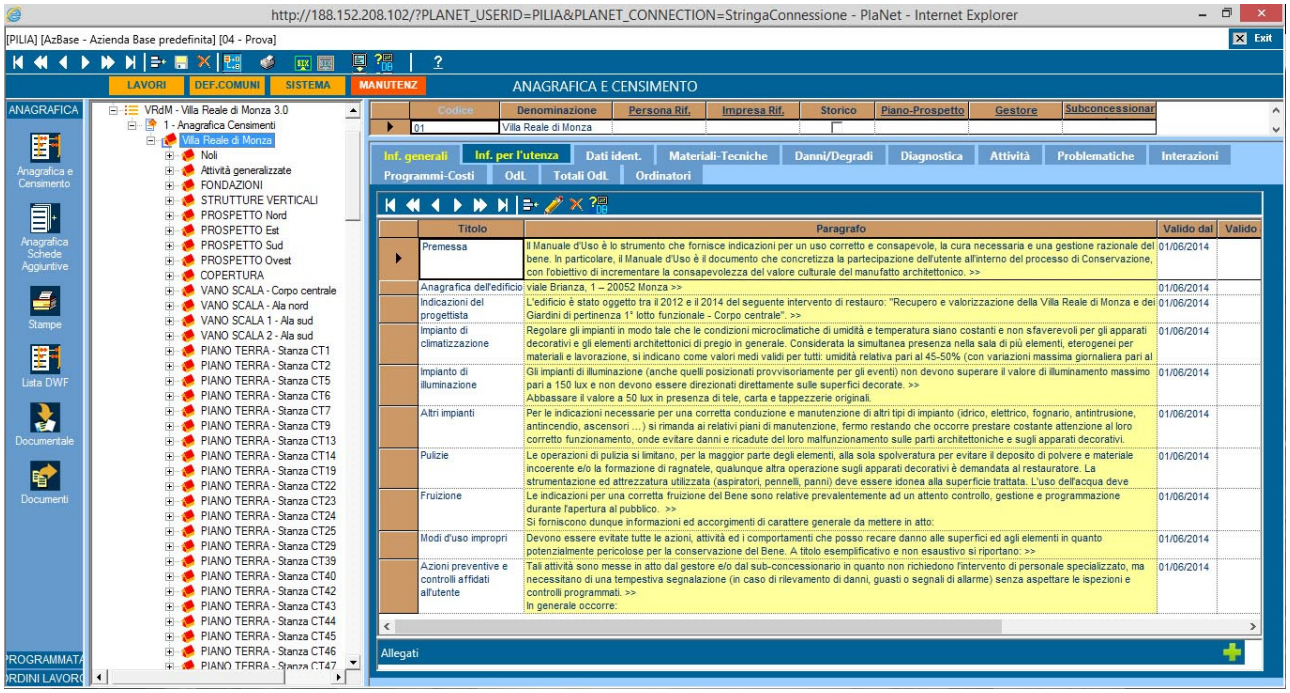
Conservation program of the Royal Villa's conservation plan in the Information System Planet and one excerpt from the print version.



ANNEX 4

CASE STUDY N. 1: ROYAL VILLA AND PARK OF MONZA

User handbook of the Royal Villa's conservation plan in the Information System Planet and one excerpt from the print version.




Piano di Conservazione
Manuale d'uso

Impianto di illuminazione

Gli impianti di illuminazione (anche quelli posizionati provvisoriamente per gli eventi) non devono superare il valore di illuminamento massimo pari a 150 lux e non devono essere direzionati direttamente sulle superfici decorate, prestando attenzione che in prossimità di tele, carta e tappezzerie originali il valore non superi i 50 lux.

Altri impianti

Per le indicazioni necessarie per una corretta conduzione e manutenzione di altri tipi di impianto (idrico, elettrico, fognario, antintrusione, antincendio, ascensori ...) si rimanda ai relativi piani di manutenzione, fermo restando che occorre prestare costante attenzione al loro corretto funzionamento, onde evitare danni e ricadute del loro malfunzionamento sulle parti architettoniche e sugli apparati decorativi.

Pulizie

Le operazioni di pulizia si limitano, per la maggior parte degli elementi, alla sola spolveratura per evitare il deposito di polvere e materiale incoerente e/o la formazione di ragnatele, qualunque altra operazione sugli apparati decorativi è demandata al restauratore. La strumentazione ed attrezzatura utilizzata (aspiratori, pennelli, panni) deve essere idonea alla superficie trattata. L'uso dell'acqua deve essere limitato, evitando il gocciolamento e ristagno della stessa sulle superfici. I prodotti utilizzati devono essere quelli indicati nel capitolato speciale d'appalto e comunque preventivamente approvati. Il trasporto dell'attrezzatura e dei prodotti deve avvenire su carrello dotato di ruote gommate per evitare cadute accidentali e il danneggiamento dei pavimenti. Durante le operazioni di pulizia evitare il deposito di attrezzi e prodotti sulle superfici, in particolare se questi risultano umidi o bagnati.

PULIZIA (su tutte le superfici ed elementi ad esclusione di tappezzerie, infissi vetrati, pavimenti e specchi che hanno una procedura specifica):
Le operazioni di pulizia prevedono la spolveratura con piumino o panno elettrostatico e pennelli di adeguate dimensioni a setole morbide per arrivare anche nei punti più stretti. Nel caso di altezze elevate si ricorrerà all'ausilio di bastone telescopico sul quale montare il piumino. Non utilizzare alcun prodotto chimico (anche se specifico per il materiale) su marmi, stucchi, legni, parti metalliche e vetri. Qualunque altra operazione oltre alla spolveratura è demandata al restauratore.

PULIZIA TAPPEZZERIE E CARTA DA PARATI:
Le operazioni di pulizia prevedono la spolveratura del tessuto per mezzo di aspirapolveri con l'utilizzo di accessorio appropriato (bocchetta a lancia) rivestito da calzina in microfibra morbida che sarà sostituita frequentemente per non trasportare la polvere da una tela all'altra. Durante l'operazione di aspirazione non esercitare forte pressione sulla tela e utilizzare guanti di cotone. L'operatore deve tenere una posizione parallela alla superficie e l'aspirazione della polvere deve essere effettuata tenendo la bocchetta inclinata di 45° rispetto alla superficie, per cui è necessario dotarsi di scala a doppio appoggio o trabattello mobile. Non pulire con sistemi a vapore e/o detergenti a secco, anche se specifici per tessuti.

PULIZIA INFISSI VETRATI:
Le operazioni di pulizia prevedono la spolveratura con piumino elettrostatico montato su bastone telescopico per raggiungere le parti più alte. I vetri devono essere puliti con panno in microfibra o cotone, con l'aggiunta di prodotto detergente neutro specifico per vetri, non schiumoso, ad azione antistatica e respingente della polvere. Durante l'operazione di pulizia evitare il percolamento di acqua e/o detergente, non applicare il prodotto detergente a spruzzo direttamente sul vetro ma versare sul panno e poi applicare sulla superficie. Attivare tutti i presidi relativi alla sicurezza dell'operatore e allo smaltimento dei prodotti.

PULIZIA PAVIMENTI LIGNEI:
Le operazioni di pulizia consistono in spolveratura e pulizia vera e propria, da effettuarsi a cadenze differenziate e in funzione del numero di visitatori.
La spolveratura deve essere eseguita regolarmente e frequentemente in funzione degli eventi e dell'affollamento; utilizzare un panno asciutto, preferibilmente elettrostatico. Durante la fase di spolveratura, se si dovesse riscontrare la presenza di pietroline o elementi che potrebbero scalfire o


Piano di Conservazione
Manuale d'uso

- In fase di allestimento e disallestimento degli eventi/mostre si consiglia un attento monitoraggio verificando che gli oggetti e arredi non vengano trascinati sul pavimento e si consiglia di comunicare tempestivamente eventuali danneggiamenti di qualsiasi genere;
- In caso di eventi che prevedano l'utilizzo della sala per buffet o attività similari, procedere alla copertura integrale del pavimento con moquette/tappeti che possono essere bloccate mediante l'utilizzo di reti gommate, adesivi adeguati o sistemi alternativi che garantiscano la corretta conservazione dei pavimenti e di prestare accurata attenzione a preservare tutte le superfici.
In caso di eventuali danneggiamenti con cibo e bevande è necessario provvedere all'asciugatura delle superfici evitando l'uso di prodotti chimici e segnalando tempestivamente l'accaduto.

Modi d'uso impropri

Devono essere evitate tutte le azioni, attività ed i comportamenti che posso recare danno alle superfici ed agli elementi in quanto potenzialmente pericolose per la conservazione del Bene. A titolo esemplificativo e non esaustivo si riportano:

- Appoggiare attrezzi, arredi mobili e scale alle superfici decorate;
- Appoggiare borse, zaini o qualunque altro oggetto alle superfici decorate;
- Appoggiare mani e piedi sulle superfici o sedersi sui pavimenti;
- Utilizzare prodotti ed attrezzature per le pulizie non idonei e non approvati preventivamente;
- Spostare oggetti e arredi trascinandoli sul pavimento;
- Posizionare (in maniera fissa e stabile) tappetti e passatole, soprattutto in prossimità di fonti di luce;
- Utilizzare chiodini, adesivi e colle per bloccare le passatole;
- Effettuare pulizie con modalità differenti da quelle indicate precedentemente, indicate dal responsabile della manutenzione e comunque non conformi al capitolato speciale d'appalto;
- Non attenersi alle indicazioni di fruizione degli spazi;
- Non attenersi alle indicazioni di impostazione degli impianti di climatizzazione e illuminazione
- Utilizzare, durante le operazioni di piccola manutenzione, materiali e tecniche di intervento non idonei.

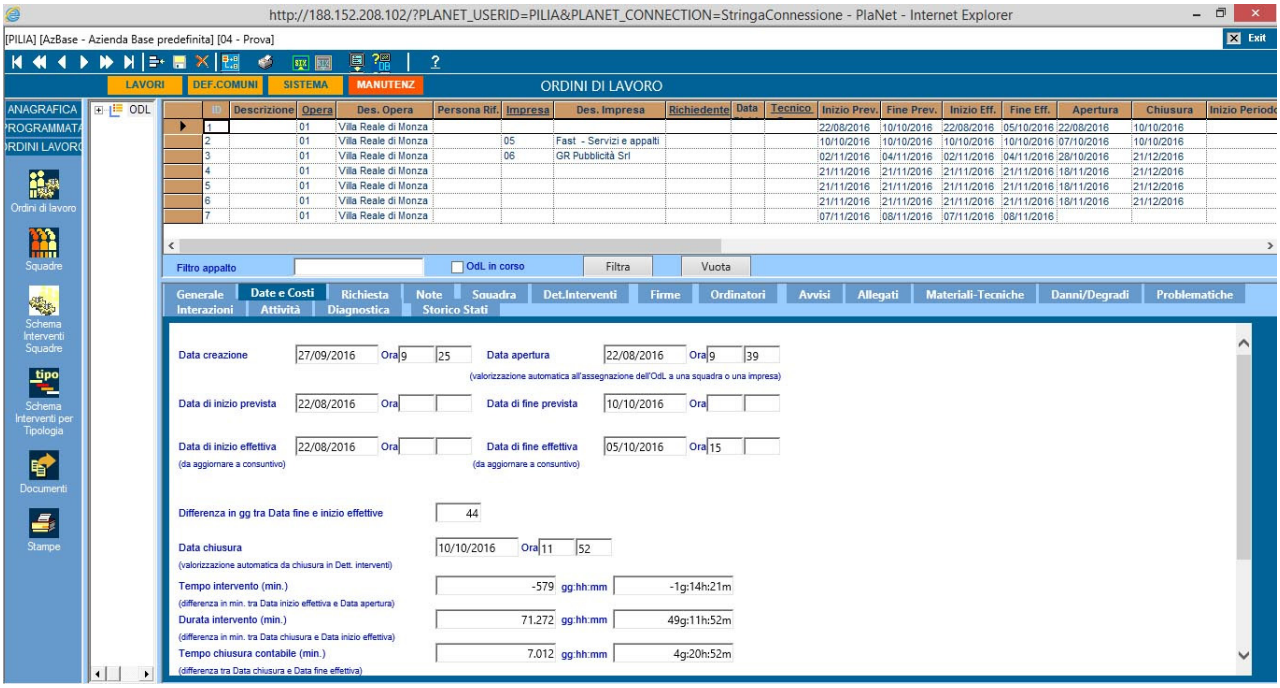
Azioni preventive e controlli affidati all'utente

Tali attività sono messe in atto dal gestore e/o dal sub-concessionario in quanto non richiedono l'intervento di personale specializzato, ma necessitano di una tempestiva segnalazione (in caso di rilevamento di danni, guasti o segnali di allarme) senza aspettare le ispezioni e controlli programmati.
In generale occorre:
- prevedere un ricambio dell'aria mediante aerazione dei locali durante le giornate con condizioni climatiche favorevoli, per esempio tale attività può essere svolta durante il tempo necessario per effettuare le pulizie all'interno della sala o durante i sopralluoghi di ricognizione occasionali effettuati a cadenza più o meno settimanale. Durante l'apertura degli infissi per far arieggiare la sala, è importante prestare attenzione al corretto funzionamento dei sistemi di movimentazione meccanica dei serramenti esterni. Nel caso in cui si rilevasse un malfunzionamento occorre segnalare il guasto al tecnico preposto alle manutenzioni. Assicurarsi che i serramenti siano richiusi al termine dell'areazione delle sale;
- verificare la chiusura delle vie di accesso e di tutti gli infissi esterni al termine degli orari di apertura al pubblico e comunque dopo le ore lavorative;
- verificare la corretta funzionalità degli impianti;
- predisporre l'applicazione di sistemi preventivi per evitare danni agli elementi quali per esempio feltrini, gommini, tacchetti ecc...
- effettuare controlli visivi sulle strutture (murature, volte, solai) eventualmente si presentassero lesioni o degradi riconducibili a problemi strutturali;
- effettuare controlli visivi sugli elementi (in particolare murature, volte, solai) eventualmente si manifestassero macchie riconducibili alla presenza di acqua nelle strutture (sia sulle strutture interne, in riferimento al corretto funzionamento degli impianti di adduzione dell'acqua e di riscaldamento, sia su quelle perimetrali in riferimento al corretto funzionamento del sistema di smaltimento delle acque meteoriche). Prestare attenzione alla eventuale presenza di deposito di intonaco polverizzato o calcinacci nelle immediate vicinanze dell'elemento o sul pavimento sottostante;
- controllare eventuali infiltrazioni di acqua dalle coperture, soprattutto dopo abbondanti piogge,

ANNEX 5

CASE STUDY N. 1: ROYAL VILLA AND PARK OF MONZA

Work orders.



SCHEDA INTERVENTO

SCHEDA INTERVENTO Tecnico Specializzato - Restauratore **DEL** 22/08/2016 **N°** 1

SQUADRA 01 Rosso / Pili **IMPRESA**

COD OPERA 01

DES OPERA Villa Reale di Monza

TEL **INDIRIZZO** **CIV.**

FAX **COMUNE** **CAP**

INIZIO PREV. 22/08/2016 **FINE PREV.** 10/10/2016 **INIZIO EFF.** 22/08/2016 **FINE EFF.** 05/10/2016 15:00 **APERTURA** 22/08/2016 9:39 **CHIUSURA** 10/10/2016 11:52

DESCRIZIONE ODL

DES. ATTIVITA'	MODALITA' OPERATIVA	ELEMENTO	DES. ELEMENTO	ESEG.
Ispezioni	Ispezioni 2016 - Programma di Conservazione	01	Villa Reale di Monza	si

PER CONFERMA FIRMA AUTOCONTROLLO VISTO DI CONTROLLO A CAMPIONE: VISTO DI CONTROLLO INFORMATICO

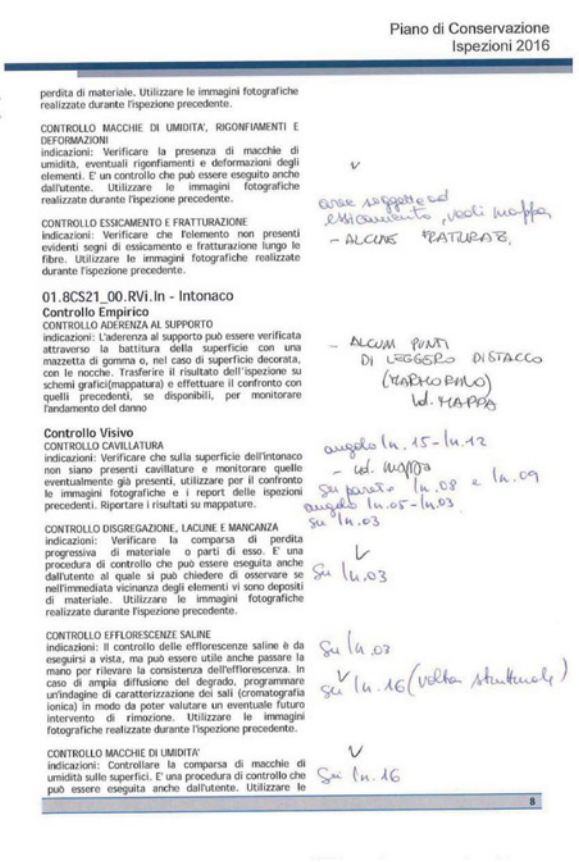
INTERVENTO ESEGUITO IL: 22/08/2016

- 1 -

ANNEX 6

CASE STUDY N. 1: ROYAL VILLA AND PARK OF MONZA

Inspection report (excerpt).



Piano di Conservazione
Ispezioni 2016

perdita di materiale. Utilizzare le immagini fotografiche realizzate durante l'ispezione precedente.

CONTROLLO MACCHIE DI UMIDITA', RIGONFIAMENTI E DEFORMAZIONI
indicazioni: Verificare la presenza di macchie di umidità, eventuali rigonfiamenti e deformazioni degli elementi. E' un controllo che può essere eseguito anche dall'utente. Utilizzare le immagini fotografiche realizzate durante l'ispezione precedente.

CONTROLLO ESSICAMENTO E FRATTURAZIONE
indicazioni: Verificare che l'elemento non presenti evidenti segni di essicamento e fratturazione lungo le fibre. Utilizzare le immagini fotografiche realizzate durante l'ispezione precedente.

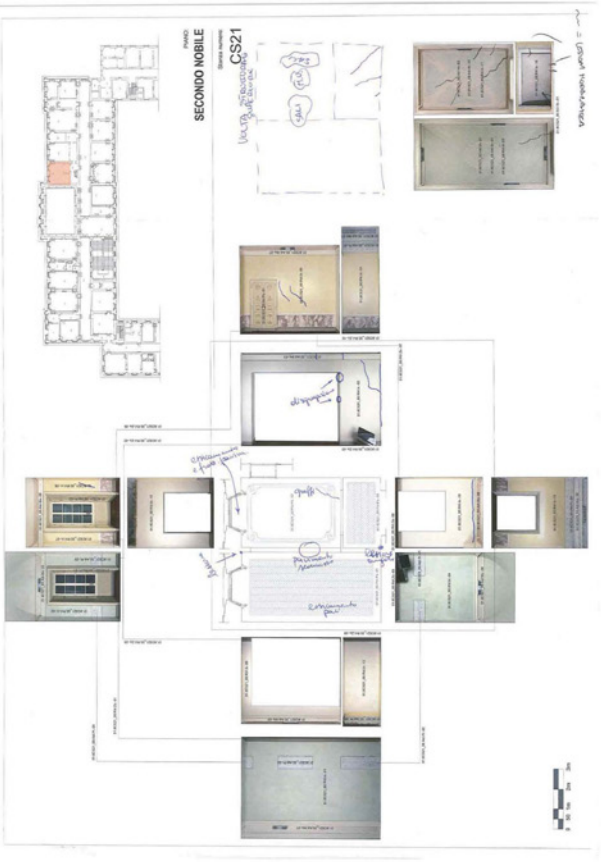
01.8CS21_00.RVi.In - Intonaco
Controllo Empirico
CONTROLLO ADERENZA AL SUPPORTO
indicazioni: L'aderenza al supporto può essere verificata attraverso la battitura della superficie con una mazzetta di gomma o, nel caso di superficie decorata, con le nocche. Trasferire il risultato dell'ispezione su schemi grafici(mappatura) e effettuare il confronto con quelli precedenti, se disponibili, per monitorare l'andamento del danno

Controllo Visivo
CONTROLLO CAVILLATURA
indicazioni: Verificare che sulla superficie dell'intonaco non siano presenti cavillature e monitorare quelle eventualmente già presenti, utilizzare per il confronto le immagini fotografiche e i report delle ispezioni precedenti. Riportare i risultati su mappature.

CONTROLLO DISGREGAZIONE, LACUNE E MANCANZA
indicazioni: Verificare la comparsa di perdita progressiva di materiale o parti di esso. E' una procedura di controllo che può essere eseguita anche dall'utente al quale si può chiedere di osservare se nell'immediata vicinanza degli elementi vi sono depositi di materiale. Utilizzare le immagini fotografiche realizzate durante l'ispezione precedente.

CONTROLLO EFFLORESCENZE SALINE
indicazioni: Il controllo delle efflorescenze saline è da eseguirsi a vista, ma può essere utile anche passare la mano per rilevare la consistenza dell'efflorescenza. In caso di ampia diffusione del degrado, programmare un'indagine di caratterizzazione dei sali (cromatografia ionica) in modo da poter valutare un eventuale futuro intervento di rimozione. Utilizzare le immagini fotografiche realizzate durante l'ispezione precedente.

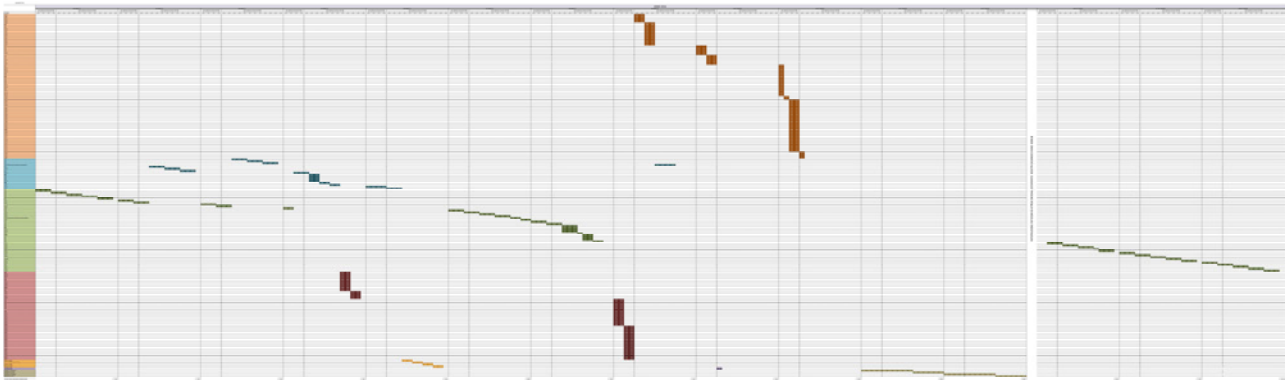
CONTROLLO MACCHIE DI UMIDITA'
indicazioni: Controllare la comparsa di macchie di umidità sulle superfici. E' una procedura di controllo che può essere eseguita anche dall'utente. Utilizzare le

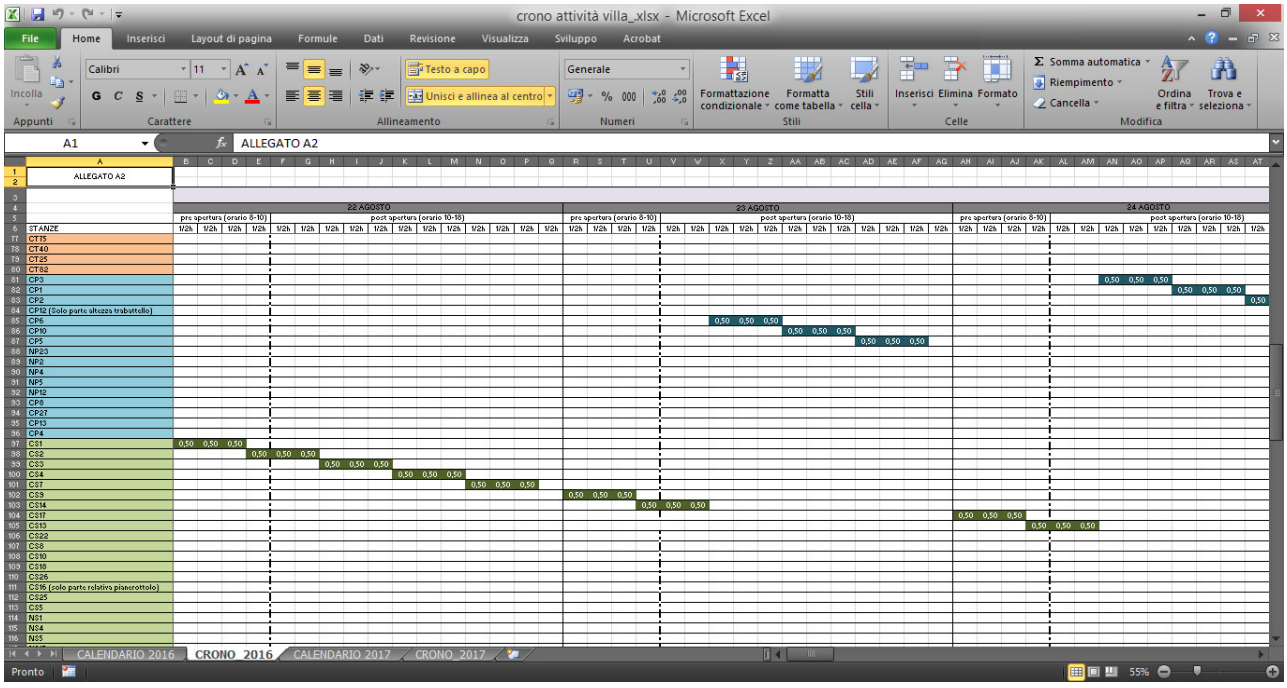


ANNEX 7

CASE STUDY N. 1: ROYAL VILLA AND PARK OF MONZA

Gantt chart of the inspection activities to be developed in the Royal Villa.





ANNEX 8

CASE STUDY N. 1: ROYAL VILLA AND PARK OF MONZA

Calendar with the time schedule of the inspection activities to be developed in the Royal Villa.

CALENDARIO 2016				
LUNEDI	MARTEDI	MERCOLEDI	GIOVEDI	VENERDI
22-ago	23-ago	24-ago	25-ago	26-ago
	4,5	4,5	4,5	3,5
7,5	3	3	1	
			2	
				4
29-ago	30-ago	31-ago	01-set	02-set
			0,5	
		2	2	2,5
		2	occupato	
8	7			
		2		
			5,5	5,5
05-set	06-set	07-set	08-set	09-set
occupato				
8	8			
		8	8	8
12-set	13-set	14-set	15-set	16-set
8	8	8	8	8
19-set	20-set	21-set	22-set	23-set
			occupato	
8	8	8	8	8
26-set	27-set	28-set	29-set	30-set
6,5	7,5	7,5		
			8	8
03-ott	04-ott	05-ott	06-ott	07-ott
8	8	8	8	8
10-ott	11-ott	12-ott	13-ott	14-ott
8	8	8	8	8

	TOTALE ORE
Fondazioni	0,50
Piano Terra	6,50
Piano Primo	19,00
Piano Secondo	51,00
Belvedere	4,00
Vani scala	4,00
Prospetti	16,00
Implementazione. S.I.	211,00

TOT. ORE ISPEZIONI	101,00
ISPEZIONI + IMPLEMENTAZIONE	312,00

GRUPPI	ISPEZIONE	MEZZO
Ambienti	CV - CE	Trabattello
Prospetti	CV	Binoccolo

N.B. lo scalone sarà ispezionato solo nella zona del pianerottolo maggiore intermedio in occasione degli interventi di ripristino della volta, quando sarà disponibile il trabattello per i lavori

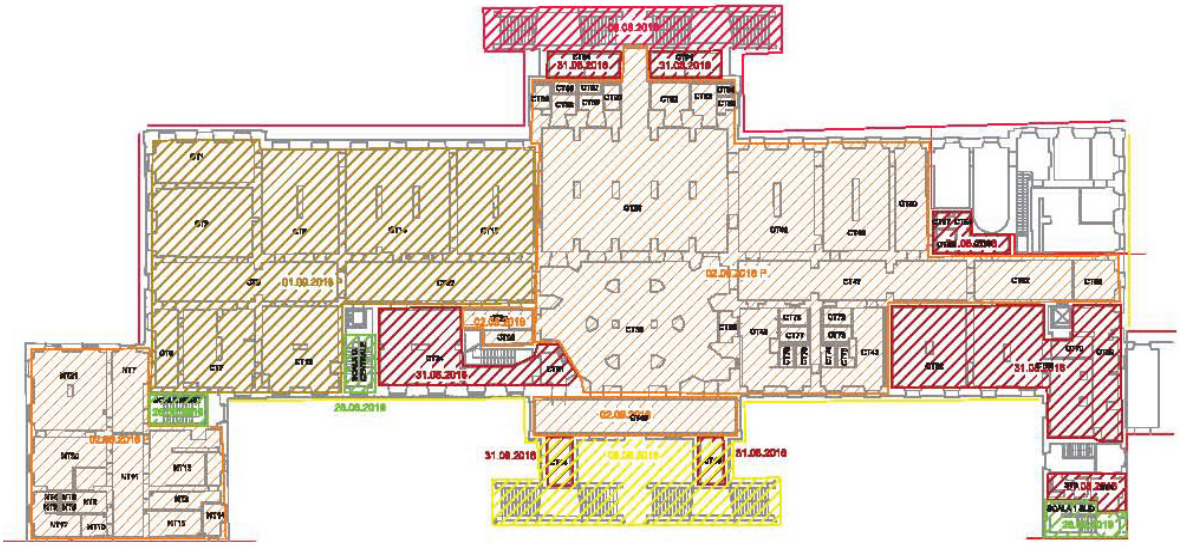
N.B. la sala da ballo sarà ispezionata solo fino ad altezza trabattello

ANNEX 9

CASE STUDY N. 1: ROYAL VILLA AND PARK OF MONZA

Plan with the time schedule of the inspection activities to be developed in the Royal Villa.

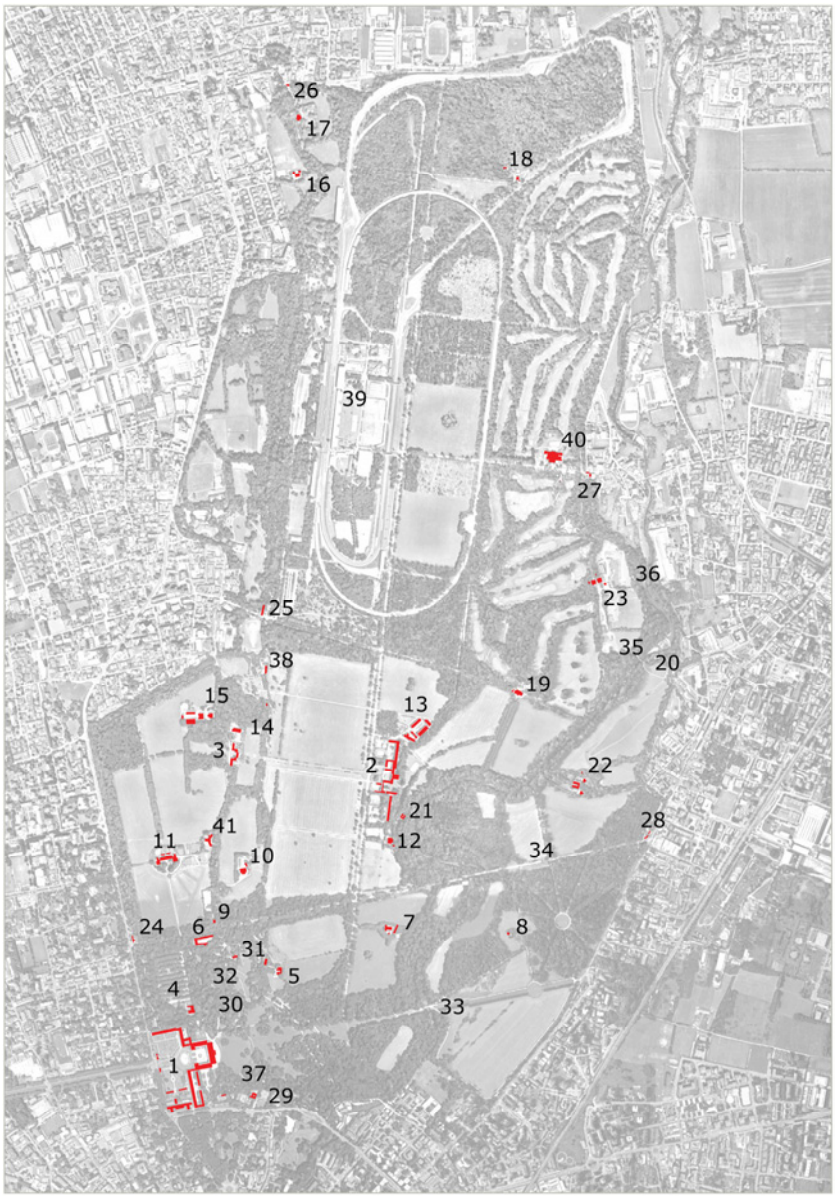
PIANO TERRA



ANNEX 10

CASE STUDY N. 1: ROYAL VILLA AND PARK OF MONZA

Orthophoto of the park and list of the buildings analyzed.



Inside the park there are about thirty buildings, each one of them is composed of some edifices, presenting different problems, different state of conservation and various functions. The buildings analysed are highlighted in bold: 1) Villa Reale, **2) Villa Mirabello**, 3) Villa Mirabellino, **4) Cascina del Forno, 5) Cascina del Sole, 6) Cascina Bastia, 7) Cascina Cernuschi, 8) Cascina Pariana, 9) Cascina Cavriga, 10) Cascina San Fedele, 11) Cascina Frutteto, 12) Cascina Cattabrega, 13) Cascina Casalta, 14) Cascina Milano, 15) Cascina Fontana, 16) Cascina Costa Alta, 17) Cascina Costa Bassa, 18) Serraglio dei Cervi, 19) Fagianaia, 20) Isolino, 21) Mulino del Cantone, 22) Mulini Asciutti, 23) Mulini San Giorgio, 24) Porta di Monza, 25) Porta di Vedano, 26) Porta di Biassono, 27) Porta di San Giorgio, 28) Porta di Villasanta, 29) Portale Neogotico, 30) Tempietto, 31) Torretta, 32) Porta-ponte Neogotico, 33) Ponte delle Catene, 34) Ponte del Cavriga, 35) Ponte dei Bertoli, 36) Ponte in Pietra,** 37) Tennis Club, 38) Ippodromo, 39) Autodromo, 40) Golf Club, 41) Rai.

ANNEX 11

CASE STUDY N. 1: ROYAL VILLA AND PARK OF MONZA

Record sheets with the data analysis related to the Park.

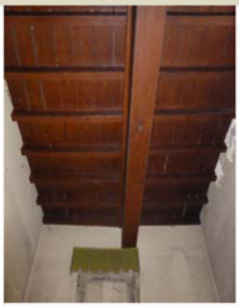
CODICE EDIFICIO: SERV.08.1
NOME EDIFICIO: Villa Mirabello, corpo centrale

MOD.3.1 SCHEDA ANALITICA
DATA SOPRALLUOGO: dicembre 2015

SO Strutture orizzontali - So Solaio, Cs Controsoffitto

Materiali e tecniche

Solaio interpiano in legno ad orditura semplice o doppia, controsoffittato in camera a canne (incannucciato) o in listelli di legno tinteggiati.



Degrado	Gravità	Urgenza	Diffusione	Note
(Cs) macchie di umidità	3	3	20%	1) Si segnala il crollo del controsoffitto in una delle camere del primo piano dell'ala nord. 2) L'appartamento è in stato di abbandono e tutti i controsoffitti in camera a canne presentano macchie di umidità (infiltrazioni provenienti dalla copertura), fessurazioni e rigonfiamenti.
(Cs, incannucciato) fessurazioni intonaco	2	2	20%	
(Cs, incannucciato) lacune intonaco	2	2	20%	
(Cs, incannucciato) distacchi canne	2	2	20%	
(Cs, incannucciato) rotture canne	2	2	20%	
(Cs, legno) esfoliazione tinteggiatura	2	2	20%	

Problematiche e anomalie attese

(So, legno, struttura) Sollecitazione meccanica / stabilità: fessurazioni, deformazioni, inflessioni, spaccature, cedimenti, dissesti, sconnesioni.
(So, legno, superficie) Idrofilia / igroscopicità: macchie di umidità, esfoliazione finiture, marcescenza.
(So, legno, superficie) Esposizione agli attacchi biologici: insetti, funghi, batteri.
(So, legno, superficie) Esposizione alle variazioni termiche: ritiri, rigonfiamenti, fessurazioni, essicazione.
(Cs, incannicciato, intonaco) Aderenza al supporto: fessurazioni, distacchi, lacune, mancanze.
(Cs, incannicciato, intonaco) Idrofilia / igroscopicità: macchie di umidità, distacchi, mancanze.
(Cs, incannicciato,canne) Aderenza al supporto: distacchi, rotture, mancanze.
(Cs, incannicciato,canne) Idrofilia / igroscopicità: macchie di umidità, marcescenza.
(Cs, tavolato in legno) Aderenza al supporto: distacchi, rotture, mancanze.
(Cs, tavolato in legno) Idrofilia / igroscopicità: macchie di umidità, esfoliazione tinteggiatura, marcescenza.

Interventi

Azioni preventive

1) Solai lignei: limitare i carichi distrubuiti eccessivi e i carichi puntuali.

Controlli

1) Controllo struttura, solaio ligneo: fessurazioni, deformazioni, inflessioni, spaccature, cedimenti, dissesti, sconnesioni. 2) controllo delle condizioni presenti nelle zone di rischio (teste delle travi). 3) controllo superficie, solaio ligneo: esfoliazione finiture, fessurazioni, essicazione, attacchi biologici, marcescenza. 4) Controllo Cs, incannuciato, intonaco: fessurazioni, distacchi, lacune, mancanze, macchie di umidità. 5) Controllo Cs, incannuciato, canne: distacchi, rotture, mancanze, macchie di umidità, marcescenza. 6) Controllo Cs, tavolato in legno: distacchi, rotture, mancanze, macchie di umidità, esfoliazione tinteggiatura, marcescenza.

Manutenzione

1) Solai lignei: disinfestazione / disinfenzione da attacchi biologici. 2) Cs, incannucciato: reintegro mancanze di piccole dimensioni. 3) Cs, tavolato in legno: sostituzione puntuale di elementi degradati.

Riparazione/restauro

1) Rimozione degli controsoffitti danneggiati e non recuperabili, ripristino e integrazione degli controsoffitti recuperabili.

Example of analytical record sheet.

CODICE EDIFCIO: SERV.08.1
NOME EDIFICIO: Villa Mirabello, corpo centrale a U

MOD.4.1 SCHEDA SINTETICA
DATA DI SOPRALLUOGO: dicembre 2015

STATO DI CONSERVAZIONE DEL BENE

Valutazione complessiva delle condizioni dell'edificio
Edificio in buone condizioni (grado 1) - parte centrale
Edificio in discrete condizioni (grado 2)
Edificio in mediocri condizioni (grado 3)
Edificio in cattive condizioni (grado 4) - ali

2012 (relazione consorzio)	2015
La Villa è stata costruita nel 1656 ed è attualmente adibita ad attività varie. Gli spazi centrali sono destinati ad attività di rappresentanza, l'ala sud al piano terreno ospita la biblioteca ed altre attività di tipo culturale. Sono presenti l'abitazione del capo operaio della manutenzione parco ed una ulteriore abitazione privata. Gli altri spazi risultano abbandonati ed in stato di avanzato degrado (ala Sud) ed i rimanenti sono destinati ad ulteriori funzioni pubbliche. Edificio ristrutturato internamente nella parte centrale ed in buono stato di manutenzione anche nelle sue parti interne adibite ad abitazioni. L'interno dell'edificio è mantenuto discretamente dalle famiglie che lo occupano le quali hanno operato una buona manutenzione ordinaria limitata alle parti di interesse abitativo, ma con scarsissima manutenzione sulle parti esterne e sugli impianti. Non risultano i contatori dell'acqua per ogni unità abitativa il cui costo del consumo è a carico dell'Amministrazione pubblica. L'appartamento sito in ala sud occupato da Roberto Tammi. non è allacciato al collettore fognario ma è servito da pozzi perdenti ormai in condizione di saturazione pressochè costante, con necessità di continui interventi di spurgo, mentre diversamente l'appartamento sito in ala nord occupato da Fiocchi Giuseppe risulta collegato. Le ali sud e nord esternamente presentano un evidente stato di degrado della facciata e della copertura. L'appartamento al primo piano ex Don Luigi è in parte adibito come deposito dei solai lignei decorati del corpo centrale della Villa Mirabello catalogati ed in attesa di restauro.	Corpo centrale a U: lo stato di conservazione della struttura risulta mediocre con delle parti completamente abbandonate e altre appena ristrutturate. Gli spazi centrali destinati ad attività di rappresentanza e il piano terra dell'ala sud che ospita la biblioteca sono state internamente ristrutturate e si presentano in buone condizioni di manutenzione. L'appartamento invece dell'ala nord che si sviluppa su due piani presenta delle infiltrazioni d'acqua dalla copertura, quali hanno provocato danni sui soffitti (incannucciati), mentre gli infissi versano ad un cattivo stato di conservazione. All'esterno dei corpi invece si notano tracce di umidità lungo la parte bassa delle murature che causa distacchi e lacune dell'intonaco e sviluppo di microflora sugli elementi lapidei della zoccolatura. Tutti gli elementi decorativi dell'atrio centrale si presentano in buone condizioni di conservazione, mentre le due torrette, l'attico e i balconi manifestano segni di umidità e degrado dell'intonaco e degli elementi lapidei. La parte posteriore verso sud-est risulta rivestita tuttora con intonaco tinteggiato di color giallo-arancione e sembra abbandonata con intenso sviluppo di vegetazione e lacune estese dell'intonaco.

Example of summary record sheet.

CODICE EDIFICIO: SERV.08.1
NOME EDIFICIO: Villa Mirabello, corpo centrale

MOD.5 PROGRAMMA

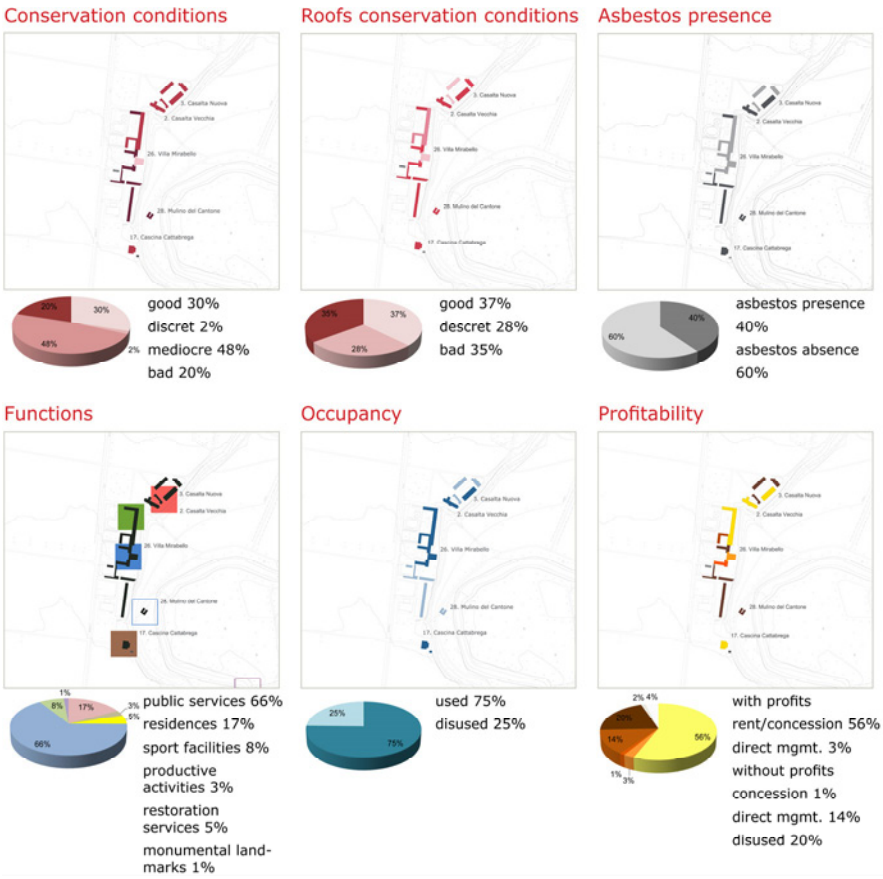
	ATTIVITA'	PRIORITA'	GENNAIO	FEBBRAIO	MARZO	APRILE	MAGGIO	GIUGNO	LUGLIO	AGOSTO	SETTEMBRE	OTTOBRE	NOVEMBRE	DICEMBRE	DA DEFINIRE
azioni preventive	Evitare mezzi e prodotti di pulizia abrasivi sulle pavimentazioni.														
	Limitare i carichi distribuiti eccessivi e i carichi puntuali.														
	Movimentare con cura le ante di finestre e sistema di oscuramento.														
	Proteggere la superficie dalla polvere in corrispondenza dei terminali dell'impianto di riscaldamento.														
controlli	Controllo delle strutture verticali, in particolare l'umidità al piede della muratura e monitoraggio delle fessurazioni.														
	Controllo delle strutture orizzontali.														
	Ispezione del sottotetto per verificare la presenza di strato di amianto nel pacchetto della copertura.	(!)													
	Controllo del manto di copertura, degli strati sottostanti e del sistema dello smaltimento delle acque.														
	Controllo delle pavimentazioni esterne e dei pavimenti interni.														
	Controllo dei rivestimenti esterni e interni.														
	Controllo degli apparati decorativi.														
	Controllo degli infissi esterni e interni.														
manutenzione	Manutenzione delle strutture verticali.														
	Manutenzione delle strutture orizzontali.														
	Manutenzione della copertura.														
	Manutenzione delle pavimentazioni.														
	Manutenzione dei rivestimenti.														
	Manutenzione degli apparati decorativi.														
	Manutenzione degli infissi.														
riparazione/restauro	Risanamento risalita e ripristino intonaco.	(!)													
	Riparazione della copertura.	(!)													
	Verifica e riparazione del corpo scala in legno, ala nord.	(!)													
	Restauro degli elementi lapidei dell'apparato decorativo (balconi, cornice attico).	(!)													
	Restauro delle pavimentazioni interne (pavimentazione in cotto e legno).														
	Restauro infissi esterni.	(!)													
	Interventi di adeguamento tecnologico: messa a norma degli impianti elettrici e del gas.	(!)													
	Interventi di adeguamento tecnologico: installazione contatori d'acqua.	(!)													
	Interventi di adeguamento tecnologico: allacciamento al collettore fognario.	(!)													
	Rimozione degli controsoffitti danneggiati e non recuperabili, ripristino e integrazione degli controsoffitti recuperabili.	(!)													
	Rimozione delle tappezzerie danneggiate e non recuperabili.														

Example of the conservation activities program.

ANNEX 12

CASE STUDY N. 1: ROYAL VILLA AND PARK OF MONZA

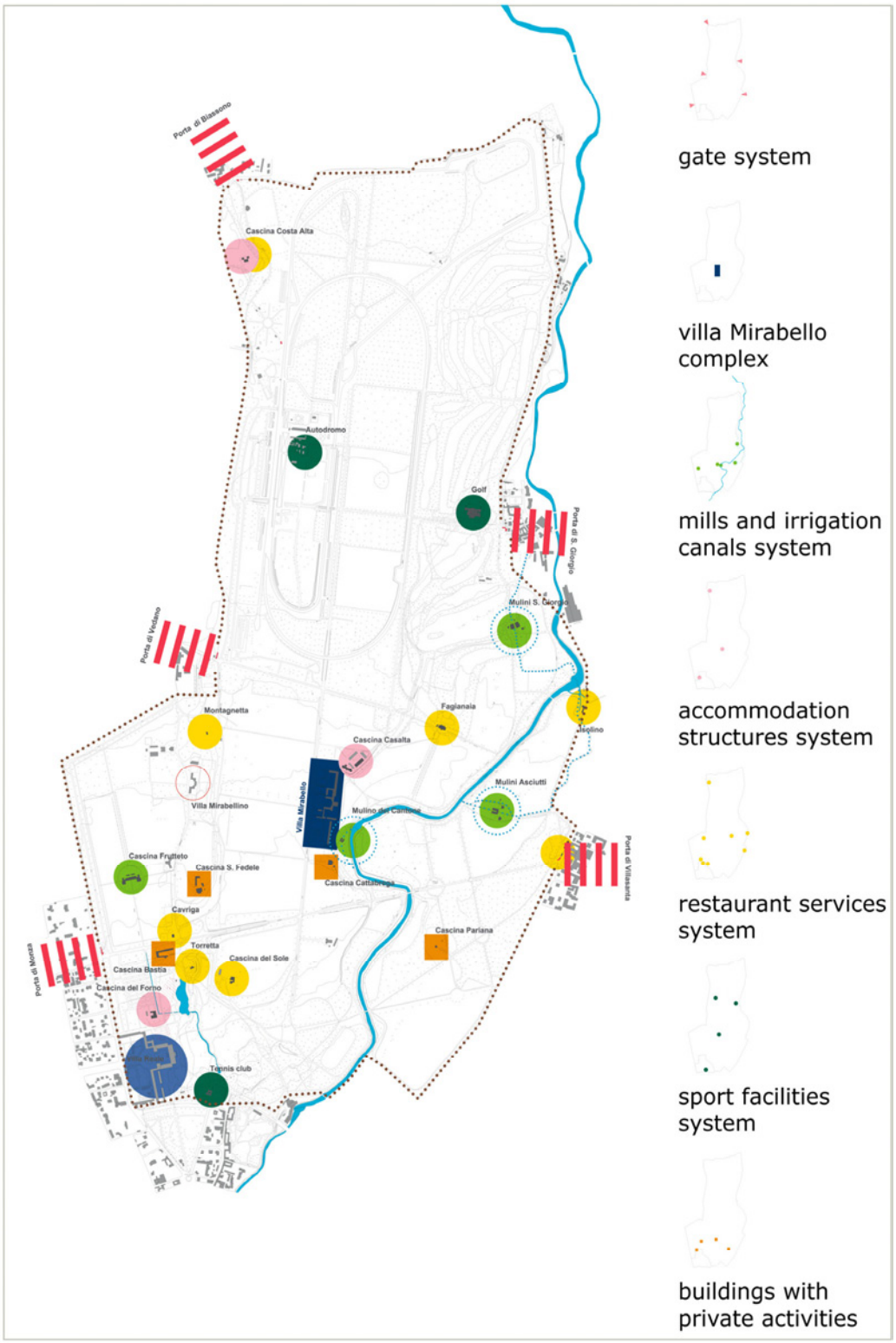
Elaboration of data.



ANNEX 13

CASE STUDY N. 1: ROYAL VILLA AND PARK OF MONZA

Proposal of master plan.



ANNEX 14

CASE STUDY N. 3: VILLA SCACCABAROZZI AND VILLA BORGIA IN THE MUNICIPALITY OF USMATE VELATE

Conservation plan of Villa Borgia (excerpt).

Edificio: villa Borgia Usmate (MB)	Piano di conservazione Manuale tecnico - Scheda 01	Classe elemento: Struttura verticale Elemento tecnologico: Muratura portante

LOCALIZZAZIONE E RILIEVO FOTOGRAFICO	
001.A.SV.Mpl_da 01 a 04, 001.A.SV.Mpl1_da 01 a 04 001.A.SV.Mpl2_da 01 a 04 001.A.SV.Mpl3_da 01 a 04	

MATERIALI E TECNICHE		
Generale	Materiale	Laterizi, malta di calce
	Tecnologia	Muratura irregolare con corsi di laterizi a giunti sfalsati e malta di allettamento di calce
	Criticità	Non direttamente visibile apparecchiatura in quanto la muratura risulta intonacata.
Descrizione estesa	Materiali e tecniche	La porzione del corpo di fabbrica del lato ovest è dotato di un piano interrato, ma solo nella parte d' angolo dell' edificio . La restante parte di edificio non è dotato di una cantina. Le murature del piano interrato, che sono la parte ispezionabile delle strutture fondali, sono costituite da muratura mista in pietra e mattoni pieni, con malta di allettamento in calce, apparentemente a base di calce magra. Le murature sono parzialmente intonacate, ma dove l' intonaco è mancante si vede la muratura in laterizi, disposti di testa, ed elementi lapidei naturali (ciotoli).

DANNI		Gravità	Urgenza	Diffusione
Validità	Dal: 01/01/2014			
	Al:2015			
Degrado, descrizione e commento	Disgregazione giunti di malta	1	1	
	Umidità di risalita	1	1	
	Disgregazione dei laterizi	1	1	

INTERVENTI	
Eseguito da	
Data di esecuzione	
Descrizione	

DIAGNOSTICA		
Generale	Nome indagine	Controllo visivo
	Eseguito da	U.T. Comunale
	Data di esecuzione	
	Esito	
Tendenza		-
Provvedimenti		Sarebbe opportuno garantire una adeguata areazione della base della muratura.

PROBLEMATICHE		
Igroscopicità	Validità	Dal: 2014

ANNEX 15

CASE STUDY N. 3: VILLA SCACCABAROZZI AND VILLA BORGIA IN THE MUNICIPALITY OF USMATE VELATE

List of inspections executed on Villa Scaccabarozzi and Villa Borgia (excerpt).

2014-2015				
edile	elettrico	idraulico	fabbro	strade
874	480	1395	121	110
3600	640	70	276	
	120	122		
	427	70		
	543	212		
	801	150		
	209	297		
	653	65		
	618	230		
		567		
		70		
		70		
		35		
		50		
4474	4491	3403	397	110

Descrizione intervento	€	Competenza	Dove
Riparazione finitura paramano fontana piazza	874	Edile	S
Manutenzione tetto e velux compresa piattaforma	3600		S
Fotocellule cancello carraio Valletta	480	Elettrico	S
Verifiche impianti e adeguamenti	640		S
Intervento per Earth Hour piazza	120		S
Verifiche impianti e sostituzioni luci	427		B
Illuminazione pubblica piazza	543		S
Lampade, placche, interruttori locali vari	801		S
Luci sala consiliare	209		B
Serrature elettriche e verifiche fontana	653		S
Illuminazione pubblica parcheggio, lampade	618		S
Manutenzione centrale termica e riparazione perdite	1395	Idraulico	S
Verifiche impianto custode	70		S
Carico automatico fontana piazza	122		S
Riparazione bagno servizio	70		B
Smontaggio e pulizia fan coil	212		B
Verifiche impianti, regolazioni	150		S
Verifiche circolatore appartamento 17	297		S
Verifiche impianti, spurgo, regolazioni	65		B
Sala colonne per circolatore e pulizia fan coil sala mostre	230		S
Pompa ricircolo ACS	567		S
Verifiche impianto	70		S
Verifiche impianto, regolazioni, spurgo	70		B
Verifiche impianto	35		S
Verifiche impianto e valvola gas	50		B
Bussola porta e pompa chiudiporta salone	121	Fabbro	S
Maniglione antipanico uscita, bussole, registrazioni	276		S
Sistemazione chiusino e cordolo	110	Strade	B
Manutenzione e verifiche	636	Ascensori	S
Manutenzione e verifiche	340	Estintori	S
Manutenzione e verifiche	240		B
Manutenzione e verifiche	246	Allarmi	S
	0	Spurghi	
Servizio annuale	150	Disinfestazione	S B
TOTALE	14487		

ANNEX 16

CASE STUDY N. 4: CA' DEI BOSSI IN THE MUNCIPALITY OF BIASSONO

Economic budget of the conservation plan.

numero attività	Attività	riferimento CME o listini prezzi (CCIAA Milano 2015 o DEI 2014)	Tipologia	Operatori	Attrezzatura	Elementi interessati	Consistenza intervento		Costi unitari (€)	Cadenza
	ATTIVITA' di CONTROLLO									
001.01	Controllo: manto di copertura in coppi	A.01.01.005 - caposquadra	Attività di controllo visivo/empirico	Team (personale interno u.t. e caposquadra)	lavoro su fune	Coperture struttura (CPSt) ; manto di copertura (CPMc)	ora	3	41,70	Annuale
001.02	Controllo dell' efficienza del sistema di smaltimento delle acque meteoriche, sia a terra che in quota	A.01.01.005 - caposquadra	Attività di controllo visivo/empirico	Team (personale interno u.t. e caposquadra)	lavoro su fune	Impianto di smaltimento delle acque meteoriche (IMSaGr , IMSaRf)	ora	4	41,70	Annuale
001.03	Controllo strutture portanti verticali e orizzontali e collegamenti verticali	A.01.01.005 - caposquadra	Attività di controllo visivo/empirico	Team (personale interno u.t. e caposquadra)	/	Strutture verticali (SVMp , SVMt) in particolare la parete Sud del corpo Nord (corte interna) per possibili movimenti dei tamponamenti rispetto al sistema strutturale con colonne in pietra e architrave ligneo; strutture orizzontali (SOVo , SOSo , SOBa) in particolare i soffitti lignei; rivestimenti esterni (RVeln) in particolare l'intonaco deumidificante della zoccolatura; rivestimenti interni (RVln); apparati decorativi esterni (ADeCo, ADeDa); Da ricordare i possibili problemi di umidità nei locali 3 e 5 a causa della mancanza del vespaio; collegamenti verticali (CVSc)	ora	8	41,70	Annuale
001.04	Controllo rivestimenti dipinti (interni ed esterni) compresi gli apparati decorativi esterni, collegamenti verticali	prezziario DEI 2014 (restauratore operatore livello AS - MO1035b: 37,51 euro/h)	Attività di controllo visivo/empirico	Team (personale interno u.t. e restauratore	/	Soffitti lignei decorati rivestimenti esterni (RVeln) in particolare l'intonaco deumidificante della zoccolatura; rivestimenti interni (RVln); apparati decorativi esterni (ADeCo, ADeDa); Da ricordare i possibili problemi di umidità nei locali 3 e 5 a causa della mancanza del vespaio; collegamenti verticali (CVSc)	ora	8	37,51	Annuale
001.05	Controllo impianto elettrico, telecomunicazione e trasmissione dati, impianto ascensore	C.04.01.0010 - installatore di 5° categoria	Attività di controllo empirico	Operaio specializzato	/	Impianto elettrico (IMElTe); impianto di telecomunicazione e trasmissione dati (IMTiTe)	ora	4	34,37	Semestrale
001.06	Controllo impianto antincendio	C.06.01.0010 installatore di 5° categoria	Attività di controllo empirico	Operaio specializzato	/	Impianto antincendio (IMASz)	ora	4	34,37	Semestrale
001.07	Controllo impianto idrosanitario e di climatizzazione	C.03.01.010/ C.01.01.0010 - installatore di 5° categoria	Attività di controllo empirico	Operaio specializzato	/	Impianto idrosanitario (IMIsTe); impianto di climatizzazione (IMCiGe, IMCiTe)	ora	4	34,37	Semestrale
001.08	Controllo empirico del funzionamento degli infissi apribili	A.01.01.005 - caposquadra	Controllo empirico	Caposquadra	trabattello	Infissi esterni (INeFi, INeOs, INeF); infissi interni (INPo)	ora	8	41,70	Annuale
	ATTIVITA' PREVENTIVE ED ATTIVITA' MANUTENTIVE AD EFFICACIA PREVENTIVA									
001.09	Pulizia periodica delle pavimentazioni interne tramite asportazione a secco dei depositi superficiali		Attività diretta sul bene ad efficacia preventiva	Gestore	/	Pavimenti interni in medoni, marmette e graniglie di cemento, (eventuale parquet): locali 02,03, 05, 07, 08,11,12, 15, 16, 19,20,21,22,23,24,26,27,28,29	mq	600	0	Bimestrale
001.10	Asportazione a secco dei depositi superficiali incoerenti da davanzali ed aggetti degli apparati decorativi, compresa la rimozione delle ragnatele dai locali e nel sottoportico		Attività diretta sul bene ad efficacia preventiva	Gestore			ore	6	0	Semestrale
001.11	Pulitura del sistema di smaltimento acque tramite rimozione meccanica guano e terriccio e pulitura pozzetti	A.01.01.025 - operaio di primo livello	Attività diretta sul bene ad efficacia preventiva	Team (personale interno u.t. e operaio)	lavoro su fune	Canali di gronda e manto di copertura	ora	6	32,30	Annuale
001.12	Revisione parziale del manto di copertura	A.01.01.0015 - operaio di IV livello	Attività diretta sul bene ad efficacia preventiva	Operaio specializzato	lavoro su fune	Coperture manto di copertura (CPMc)	ore	8	40,10	Annuale
001.13	Stesura sui pavimenti di cere protettive che rallentino i fenomeni di usura (Cfr. protettivo Geal da miglioria impresa)	prezziario DEI 2014 (restauratore operatore livello AS - MO1035b: 37,51 euro/h) A.01.01.0020 - operaio di III livello (38,10 euro/h)	Attività diretta sul bene ad efficacia preventiva	Restauratore	/	Pavimenti interni in medoni, marmette e graniglie di cemento, (eventuale parquet)	mq	500	7,00	Annuale
001.14	Trattamento protettivo elementi metallici	A.01.01.0020 - operaio di III livello	Attività protettiva	Operaio specializzato	/	Inferriate	ora	16	38,10	Quinquennale
001.15	Lubrificazione degli elementi di movimentazione degli infissi	A.01.01.025 - operaio di primo livello	Attività protettiva	Operaio	/	Infissi interni e infissi esterni (INe.Fi , Ine.Os)	ora	4	32,30	Annuale
001.16	Stesura protettivo silossanico in base acquosa sugli intonaci esterni	prezziario DEI 2014 - 055048b	Attività manutentiva	Restauratore	piattaforma	Intonaci esterni in malta di calce	mq	1.200	24,92	Ogni dieci anni (da dilazionare tra il quinto e decimo anno)
00.17	Predisposizione di shermature interne	/				locali open space (n. 28/29). In totale 9 finestre	a corpo	1	5000,00	una tantum. Da prevedersi in fase iniziale
	ATTIVITA' DI STUDIO									
001.18	Aggiornamento del piano di conservazione con le informazioni delle attività svolte			Personale interno u.t.	/		ore	8	73,50	Annuale
001.19	Revisione delle attività programmate			Personale interno u.t.	/		ore	12	73,50	Quinquennale
	ATTREZZATURE									
	Nolo piattaforma					Il nolo della piattaforma è necessario solo per l'attività di stesura del protettivo (001.17)	giorni	8	400,00	Solo per la attività di stesura del protettivo prevista per lotti dal quinto al decimo anno

numero attività	Attività	Cadenza	2017	2018	2019	2020	2021	20122	2023	2024	2025	2026
	ATTIVITA' di CONTROLLO											
001.01	Controllo: manto di copertura in coppi	Annuale	€ 125	€ 125	€ 125	€ 125	€ 125	€ 125	€ 125	€ 125	€ 125	€ 125
001.02	Controllo dell' efficienza del sistema di smaltimento delle acque meteoriche, sia a terra che in quota	Annuale	€ 167	€ 167	€ 167	€ 167	€ 167	€ 167	€ 167	€ 167	€ 167	€ 167
001.03	Controllo strutture portanti verticali e orizzontali con relativi rivestimenti (interni ed esterni) compresi gli apparati decorativi esterni, collegamenti verticali	Annuale	€ 334	€ 334	€ 334	€ 334	€ 334	€ 334	€ 334	€ 334	€ 334	€ 334
001.04	Controllo strutture portanti verticali e orizzontali con relativi rivestimenti (interni ed esterni) compresi gli apparati decorativi esterni, collegamenti verticali	Annuale	€ 300	€ 300	€ 300	€ 300	€ 300	€ 300	€ 300	€ 300	€ 300	€ 300
001.05	Controllo impianto elettrico, telecomunicazione e trasmissione dati	Semestrale	€ 275	€ 275	€ 275	€ 275	€ 275	€ 275	€ 275	€ 275	€ 275	€ 275
001.06	Controllo impianto antincendio	Semestrale	€ 275	€ 275	€ 275	€ 275	€ 275	€ 275	€ 275	€ 275	€ 275	€ 275
001.07	Controllo impianto idrosanitario e di climatizzazione	Semestrale	€ 275	€ 275	€ 275	€ 275	€ 275	€ 275	€ 275	€ 275	€ 275	€ 275
001.08	Controllo empirico del funzionamento degli infissi apribili	Annuale	€ 334	€ 334	€ 334	€ 334	€ 334	€ 334	€ 334	€ 334	€ 334	€ 334
	ATTIVITA' PREVENTIVE E ATTIVITA' MANUTENTIVE AD EFFICACIA											
001.09	Pulitura periodica delle pavimentazioni interne tramite asportazione a secco dei depositi superficiali	Bimestrale	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
001.10	Asportazione a secco dei depositi superficiali incoerenti da davanzali ed aggetti degli apparati decorativi, compresa la rimozione delle ragnatele dai locali e nel sottoportico	Semestrale										
001.11	Pulitura del sistema di smaltimento acque tramite rimozione meccanica guano e terriccio e pulitura pozzetti	Annuale	€ 194	€ 194	€ 194	€ 194	€ 194	€ 194	€ 194	€ 194	€ 194	€ 194
001.12	Revisione parziale del manto di copertura	Annuale	€ 321	€ 321	€ 321	€ 321	€ 321	€ 321	€ 321	€ 321	€ 321	€ 321
001.13	Stesura sui pavimenti di cere protettive che rallentino i fenomeni di usura	Annuale	€ 3.500	€ 3.500	€ 3.500	€ 3.500	€ 3.500	€ 3.500	€ 3.500	€ 3.500	€ 3.500	€ 3.500
001.14	Trattamento protettivo elementi metallici	Quinquennale	€ -	€ -	€ -	€ -	€ 610	€ -	€ -	€ -	€ -	€ 610
001.15	Lubrificazione degli elementi di movimentazione degli infissi	Annuale	€ 129	€ 129	€ 129	€ 129	€ 129	€ 129	€ 129	€ 129	€ 129	€ 129
001.16	stesura protettivo silossanico in base acquosa sugli intonaci esterni	Ogni dieci anni (da dilazionare tra il quinto e decimo anno)	€ -	€ -	€ -	€ -	€ -	€ 5.981	€ 5.981	€ 5.981	€ 5.981	€ 5.981
00.17	Predisposizione di shermature interne		€ 5.000	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -	€ -
	ATTIVITA' DI STUDIO											
001.18	Aggiornamento del piano di conservazione con le informazioni delle attività svolte	Annuale	€ 588	€ 588	€ 588	€ 588	€ 588	€ 588	€ 588	€ 588	€ 588	€ 588
001.19	Revisione delle attività programmate	quinquennale	€ -	€ -	€ -	€ -	€ 882	€ -	€ -	€ -	€ -	€ 882
	ATTREZZATURE											
001.20	Nolo piattaforma		€ -	€ -	€ -	€ -	€ -	€ 800	€ 800	€ 800	€ 800	€ 800

ANNEX 17

CASE STUDIES N. 5: INSPECTIONS - SAFETY FOR ACCESSIBILITY
Arco Castle (Trento)

REPORT ISPEZIONE ARCHITETTONICA				
Denominazione	Località	Data ispezione	**SCHEDA 1**	Pag
Castello di Arco	Arco – Via Castello 45°55'18.8"N, 10°53'16.8"E	03/07/2017	**ANAGRAFICA**	2

DESCRIZIONE BREVE	
Luogo	Castello di Arco di Trento
Tipologia edificio	Cinta muraria del Castello
Destinazioni d'uso	Museale
Impianto strutturale	Il castello di Arco è posto su una rupe che sovrasta l'abitato di Arco. E' articolato secondo la sommità della rupe su una pianta sostanzialmente quadrangolare con ai vertici:la Torre Renghera, la nuova scala di salita, la Guarda di Mezzo e la Torre del Laghel. Lungo il perimetro della rupe sorgono le mura, di cui sono rimasti tratti attualmente di altezza molto variabile. Al centro sorge la Torre Grande, unita alla Torre Renghera da un tratto di mura interne, disposte lungo la linea di massima pendenza.
Evoluzione	Reperti archeologici attestano la presenza sulla rupe di insediamenti precedenti all'epoca medievale. E' certa l'esistenza del castello già attorno all'anno 1000, costruito dai nobili della comunità di Arco per scopi difensivi. Dal XIII sec. Il castello diventò proprietà della famiglia dei conti di Arco, di cui fu proprietà in modo continuativo con eccezione di un periodo tra il 1579 ed il 1614 Nel 1703, nell'ambito della guerra di successione spagnola, il castello fu bombardato dai francesi, dopo di che fu abbandonato ed andò in rovina. Nel 1982 il castello è stato finalmente acquistato dal comune di Arco.
Interventi	Dopo l'acquisto da parte del comune il Servizio Beni Culturali della Provincia Autonoma di Trento ha avviato radicali lavori di restauro: Il consolidamento della Torre Grande, Torre Renghera e Torre del LAghel, il consolidamento delle mura di cinta, il recupero dell'antica strada, di alcuni perimetri di edifici, il recupero di due cisterne, della stanza del sartor, della sala degli affreschi.
Descrizione del contesto edificato	
Note:	

REPORT ISPEZIONE ARCHITETTONICA				
Denominazione	Località	Data ispezione	**SCHEDA 1**	Pag
Castello di Arco	Arco – Via Castello 45°55'18.8"N, 10°53'16.8"E	03/07/2017	**ANAGRAFICA**	3

DESCRIZIONE ESTESA	
NOTIZIE STORICHE:	 L'aspetto del castello reso da un acquerello del 1495 di Albrecht Durer.
DESCRIZIONE:	

REPORT ISPEZIONE ARCHITETTONICA				
Denominazione	Località	Data ispezione	**SCHEDA 1**	Pag
Castello di Arco	Arco – Via Castello 45°55'18.8"N, 10°53'16.8"E	03/07/2017	**ANAGRAFICA**	4

RAPPRESENTAZIONE GRAFICA E FOTOGRAFICA

Vista da Sud

Vista da Ovest

REPORT ISPEZIONE ARCHITETTONICA				
Denominazione	Località	Data ispezione	**SCHEDA 1**	Pag
Castello di Arco	Arco – Via Castello 45°55'18.8"N, 10°53'16.8"E	03/07/2017	**ANAGRAFICA**	5

Vista da Nord

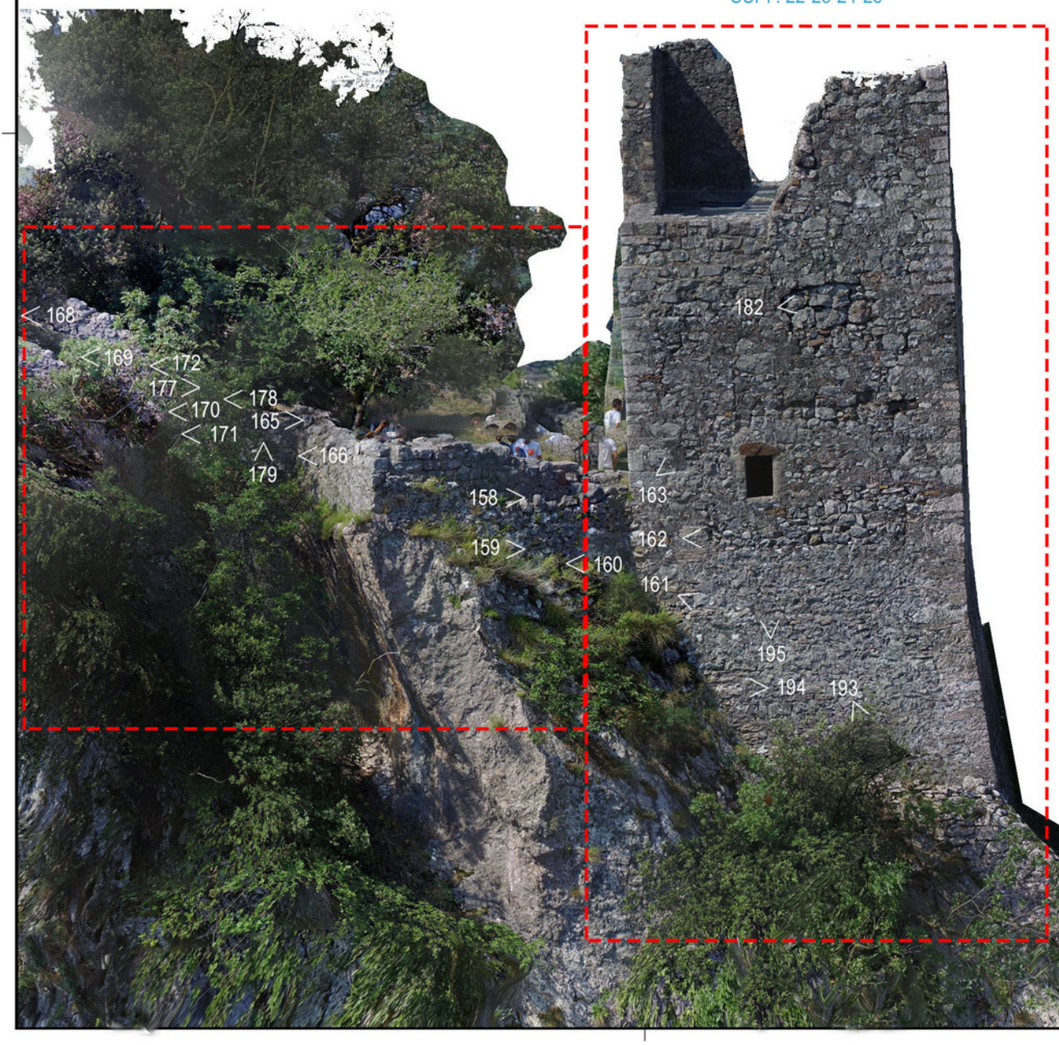
Vista da Est

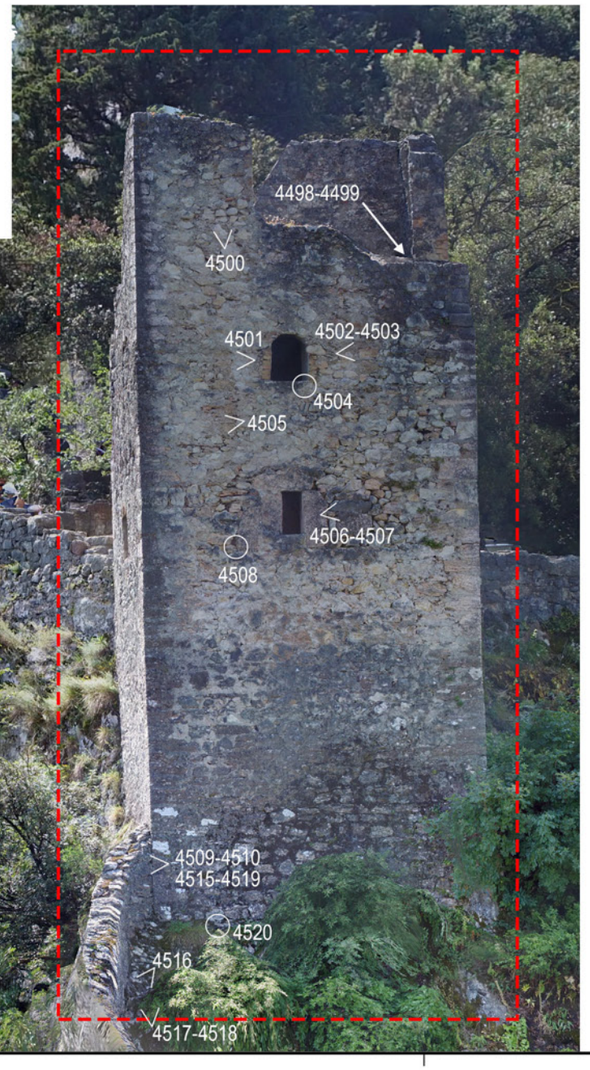
AREA 06
SUPP. 27

AREA 06
SUPP. 28

AREA 06_Prospetto torre
SUPP. 22-23-24-25

AREA 06_Prospetto torre
SUPP. 26-29





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FOPPOLI MORETTA e ASSOCIATI
società di ingegneria

FAARCHITETTO
SERVIZI PER LA CONSERVAZIONE DEL PATRIMONIO

CASTELLO DI ARCO DI TRENTO

RILIEVO AEROFOTOGRAMMETRICO
CON LOCALIZZAZIONE
RIPRESE FOTOGRAFICHE

AREA	SUPPORTO
06	22-23-24-25 26-27-28-29

REPORT ISPEZIONE

DENOMINAZION	LOCALITÀ	ISPEZIONE	DOCUMENT	ELEMENTO				
				Classe	Sottoclasse	Supporto	Sub	n
Castello di Arco	Arco – Via Castello 45°55'18.8"N, 10°53'16.8"E	03/07/2017	Schede tecniche	SV	MP	25		

DESCRIZIONE

IMMAGINE

DESCRIZIONE TECNOLOGICA

Muro costituente il perimetro della torre di Laghel, con andamento perpendicolare al forte declivio e fondato su roccia si eleva fuori terra sicuramente per circa metà altezza, mentre la parte inferiore non è visibile.
In sommità il muro non risulta concluso, le acque sono gestite mediante scivoli di malta tra i conci.
il muro è parzialmente crollato e in parte ricostruito in sottosquadro probabilmente per permettere la posa del solaio di copetura. Il muro presenta un piccola finestra con architrave litico e una discontinuità rettilinea ad andamento verticale superiormente all'apertura che potrebbe essere addebitabile a differenti fasi costruttive
Il prospetto esterno è rivolto a nord mentre il prospetto interno rivolto a sud non è visibile nella parte inferiore, e risulta protetto da una copertura per la quasi totalità dell'altezza.
La muratura è realizzata in pietra calcarea sbozzata con posa irregolare, angoli parzialmente costituiti da pietre squadrate e legata da malta di calce con inerti da millimetrici a centimetrici.
La fugatura in malta di calce molto alta a creare una superficie regolare.
Esposizione Nord, Sud
STATO DI CONSERVAZIONE GENERALE:
La muratura si presenta sostanzialmente solida, ben appoggiata alla roccia, un legante generalmente in buono stato, buono anche lo stato della superficie sommitale.

Anno di realizzazione	Non noto
Documentazione fotografica ispezione	..\..\0 Documentazione fotografica ispezione\Supporto 25

INTERVENTI

Non individuati

Anno di realizzazione						
ELEMENTI	CLASSE	SOTTOCLAS	SUPPORTO	SUB	NUMERO	DOCUM

DIAGNOSTICA E RILIEVI

Rilievo mediante drone con fotoraddrizzamenti dei prospetti esterni

Anno di realizzazione	07/2017 (contestualmente all'ispezione)					
ELEMENTI	CLASSE	SOTTOCLAS	SUPPORTO	SUB	NUMERO	DOCUM
	SV	MP	1-36			Area 6 Sup 22-23-24-25-26-27-28-29

REPORT ISPEZIONE

DENOMINAZION	LOCALITÀ	ISPEZIONE	DOCUMENT	ELEMENTO				
				Classe	Sottoclasse	Supporto	Sub	n
Castello di Arco	Arco – Via Castello 45°55'18.8"N, 10°53'16.8"E	03/07/2017	Schede tecniche	SV	MP	25		

DANNI

DISGREGAZIONE GIUNTI DI MA

DIFFUSIONE 0-25%

DESCRIZIONE

Il prospetto presenta disgregazione profonda delle malte di allettamento fino a risultare assenti per tutta la profondità dei primi conci che infatti si sono adagiati su se stessi.

ISTRUZIONI

Le aree degradate rappresentano risultano molto localizzate fatto che può far pensare a non meglio precisati fenomeni circoscritti, che andranno indagati in occasione dell'auspicato intervento di messa in sicurezza.

DOCUMENTAZIONE IMG_0182

GRAVITÀ

Il fenomeno che interessa la muratura sebbene localizzato risulta puntualmente grave.

3	CONSERVATIVA	1	2	**3**
	FRUIBILITÀ	**1**	2	3
	ECONOMICA	**1**	2	3

URGENZA

Le pietre risultano sostanzialmente non legate con possibilità di imminente caduta delle medesime lungo il versante e la conseguente instabilizzazione di ulteriore porzioni di muratura, come già visibile.

3	CONSERVATIVA	1	2	**3**
	FRUIBILITÀ	**1**	2	3
	ECONOMICA	**1**	2	3

COLONIZZAZIONE BIOLOGICA

DIFFUSIONE 25-50%

DESCRIZIONE

Il prospetto si presenta ricoperto di patine biologiche, che ricoprono in particolare le malte, mentre alcune piante erbacee sono presenti al piede

ISTRUZIONI

L a presenza della risega al piede della muratura favorisce l'accrescimento di piante superiori.

DOCUMENTAZIONE IMG_0194

GRAVITÀ

Il fenomeno che interessa la muratura seppur diffuso non appare grave per tipologia e dimensioni delle specie.

1	CONSERVATIVA	**1**	2	3
	FRUIBILITÀ	**1**	2	3
	ECONOMICA	**1**	2	3

URGENZA

La tipologia di vegetazione presente non comporta urgenze significative .

1	CONSERVATIVA	**1**	2	3
	FRUIBILITÀ	**1**	2	3
	ECONOMICA	**1**	2	3

REPORT ISPEZIONE

DENOMINAZION	LOCALITÀ	ISPEZIONE	DOCUMENTO	ELEMENTO				
				Classe	Sottoclasse	Supporto	Sub	n
Castello di Arco	Arco – Via Castello 45°55'18.8"N, 10°53'16.8"E	03/07/2017	Schede tecniche	SV	MP	25		

PROGRAMMA

AZIONI

1 — DISGREGAZIONE GIUNTI DI MALT

RISTILATURA PROFONDA DEI GIUNTI
Prospetto esterno

ATTIVITÀ	CLASSE	SOTTOC	SUPPORTO	SUB	NUM	MODALITÀ	ACCESSIBILITÀ	DATA	OPERATORE	
A	Sv	Mp	25			Lavoro	In fune	Breve termine	Operaio	OG2

2 — COLONIZZAZIONE BIOLOGICA

TRATTAMENTO BIOCIDA E SUCCESSIVA ASPORTAZIONE DELLA VEGETAZIONE.
Prospetto esterno

ATTIVITÀ	CLASSE	SOTTOC	SUPPORTO	SUB	NUM	MODALITÀ	ACCESSIBILITÀ	DATA	OPERATORE	
A	Sv	Mp	25			Lavoro	In fune	Medio lungo termine	Operaio	OG2

3 — COLONIZZAZIONE BIOLOGICA

CREAZIONE DI SCIVOLO DI DEFLUSSO ACQUE METEORICHE.
Al piede della muratura ove necessario

ATTIVITÀ	CLASSE	SOTTOC	SUPPORTO	SUB	NUM	MODALITÀ	ACCESSIBILITÀ	DATA	OPERATORE	
A	Sv	Mp	25			Lavoro	In fune	Medio lungo termine	Operaio	OG2

NOTE INDICAZIONI	

REPORT ISPEZIONE

DENOMINAZION	LOCALITÀ	ISPEZIONE	DOCUMENT	ELEMENTO				
				Classe	Sottoclasse	Supporto	Sub	n
Castello di Arco	Arco – Via Castello 45°55'18.8"N, 10°53'16.8"E	03/07/2017	Schede tecniche	SV	MP	26		

DESCRIZIONE

IMMAGINE

DESCRIZIONE TECNOLOGICA

Muro perimetrale Nord della torre di Laghel. La torre è posta al bordo della rupe in posizione fortemente strapiombante, lo spigolo Nord-Est della torre è sullo spigolo dello strapiombo. Sono presenti due aperture a differenti livelli di cui quella inferiore trilitica.
Il coronamento del muro non risulta concluso e non presenta sistemi di smaltimento acque (ad es. copertine). Nello spigolo Nord-Est la muratura risulta più alta in quanto si è conservato un tratto del coronamento originale.

La muratura è realizzata in pietra calcarea sbozzata con posa irregolare, angoli parzialmente costituiti da pietre squadrate e legata da malta di calce con inerti da millimetrici a centimetrici. La sigillatura delle fughe (sebbene attualmente degradata) risulta in origine molto alta a creare una superficie regolare.
Esposizione Ovest, Est

STATO DI CONSERVAZIONE GENERALE:
La muratura risulta solida e fondata su una muratura a scarpa, a sua volta ben appoggiata alla roccia affiorante; questa muratura a scarpa, in buone condizioni , presenta pochi distacchi localizzati.

Anno di realizzazione	Non noto
Documentazione fotografica ispezione	..\..\0_Documentazione fotografica ispezione\Supporto 26

INTERVENTI

Non individuati

Anno di realizzazione						
ELEMENTI	CLASSE	SOTTOCLASS	SUPPORTO	SUB	NUMERO	DOCUM

DIAGNOSTICA E RILIEVI

Rilievo mediante drone con fotoraddrizzamenti dei prospetti esterni

Anno di realizzazione	07/2017 (contestualmente all'ispezione)					
ELEMENTI	CLASSE	SOTTOCLASS	SUPPORTO	SUB	NUMERO	DOCUM
	SV	MP	1-36			Area 6_Sup 22-23-24-25-26-27-28-29

REPORT ISPEZIONE

DENOMINAZIONE	LOCALITÀ	ISPEZIONE	DOCUMENTO	ELEMENTO				
				Classe	Sottoclasse	Supporto	Sub	n
Castello di Arco	Arco – Via Castello 45°55'18.8"N, 10°53'16.8"E	03/07/2017	Schede tecniche	SV	MP	26		

DANNI

DISGREGAZIONE GIUNTI DI MA

DIFFUSIONE

DESCRIZIONE

La muratura risulta disgregata in corrispondenza del parapetto della finestra superiore e dei piedritti della finestra inferiore

ISTRUZIONI

Le aree degradate sono molto localizzate e risultano evidentemente attribuibili a fenomeni circoscritti correlati alla presenza delle aperture.

DOCUMENTAZIONE IMG_4504

GRAVITÀ

Il fenomeno che interessa la muratura risulta localizzato.

2	CONSERVATIVA	1	2	3
	FRUIBILITÀ	1	2	3
	ECONOMICA	1	2	3

URGENZA

Il fenomeno può progredire causando la sconnessione delle pietre.

2	CONSERVATIVA	1	2	3
	FRUIBILITÀ	1	2	3
	ECONOMICA	1	2	3

COLONIZZAZIONE BIOLOGICA

DIFFUSIONE

DESCRIZIONE

Il colore scuro visibile nella parte bassa della muratura corrisponde ad una forte presenza di licheni.
La muratura della scarpa è ricoperta di muschio e presenta sviluppo di vegetazione superiore nei giunti, ma risulta tuttavia in buone condizioni di conservazione con pochi distacchi localizzati.

ISTRUZIONI

La presenza di licheni non costituisce un problema di conservazione e può essere correlata alla possibile presenza di una malta differente forse da mettere in relazione a restauri moderni.
La presenza della muratura al piede della muratura favorisce l'accrescimento di piante superiori.

DOCUMENTAZIONE IMG_4520

GRAVITÀ

La presenza di muschi non appare rilevante. La presenza di piante superiori può favorire un'ulteriore colonizzazione.

2	CONSERVATIVA	1	2	3
	FRUIBILITÀ	1	2	3
	ECONOMICA	1	2	3

URGENZA

le piante superiori devono essere rimosse perché il loro progredire può causare problemi di scalzamento dei blocchi.

2	CONSERVATIVA	1	2	3
	FRUIBILITÀ	1	2	3
	ECONOMICA	1	2	3

REPORT ISPEZIONE

DENOMINAZION	LOCALITÀ	ISPEZIONE	DOCUMENTO	ELEMENTO				
				Classe	Sottoclasse	Supporto	Sub	n
Castello di Arco	Arco – Via Castello 45°55'18.8"N, 10°53'16.8"E	03/07/2017	Schede tecniche	SV	MP	26		

PROGRAMMA

AZIONI												
1	DISGREGAZION GIUNTI DI MALT	RISTILATURA PROFONDA DEI GIUNTI Prospetto esterno										
		ATTIVITÀ	CLASSE	SOTTOC	SUPPORTO	SUB	NUM	MODALITÀ	ACCESSIBILITÀ	DATA	OPERATORE	
		A	Sv	Mp	26			Lavoro	In fune	medio termine	Operaio	OG2
2	COLONIZZAZIO BIOLOGICA	TRATTAMENTO BIOCIDA E SUCCESSIVA ASPORTAZIONE DELLA VEGETAZIONE. Al piede del paramento esterno.										
		ATTIVITÀ	CLASSE	SOTTOC	SUPPORTO	SUB	NUM	MODALITÀ	ACCESSIBILITÀ	DATA	OPERATORE	
		A	Sv	Mp	26			Lavoro	In fune	medio termine	Operaio	OG2

NOTE INDICAZIONI	

REPORT ISPEZIONE

DENOMINAZION	LOCALITÀ	ISPEZIONE	DOCUMENT	ELEMENTO				
				Classe	Sottoclasse	Supporto	Sub	n
Castello di Arco	Arco – Via Castello 45°55'18.8"N, 10°53'16.8"E	03/07/2017	Schede tecniche	SV	MP	27		

DESCRIZIONE

IMMAGINE

DESCRIZIONE TECNOLOGICA

Muro perimetrale Ovest della torre di Laghel. E' presente a metà altezza un'apertura trilitica.
Il coronamento del muro non presenta sistemi di smaltimento acque; nello spigolo Sud-Ovest la muratura risulta più alta , evidentemente residuo del coronamento originale della torre. Da tale rialzo si è già staccato un blocco caduto all'interno della copertura. La parte alta della muratura appare ricostruita in sottosquadra, probabilmente per consentire l'appoggio della copertura. E' costituita da pietra grigia (come nella parte sottostante) ma senza scaglie di mattoni nei giunti.
Lo spigolo Sud, costituito da pietra calcarea bianco-rosacea come la spigolo opposto, mostra un giunto di costruzione; il corpo murario è costituito da pietra grigia. Lo spigolo Nord è segnato da una fessura, attualmente sigillata.

La muratura è realizzata in pietra calcarea sbozzata con posa irregolare, angoli costituiti da pietre squadrate e legata da malta di calce con inerti da millimetrici a centimetrici. La sigillatura delle fughe (sebbene attualmente degradata) risulta in origine molto alta a creare una superficie regolare.
Esposizione Nord, Sud

STATO DI CONSERVAZIONE GENERALE:
La muratura non mostra movimenti i corrispondenza della fessura esistente; il coronamento ha già mostrato cadute di materiale.

Anno di realizzazione	Non noto
Documentazione fotografica ispezione	..\..\0_Documentazione fotografica ispezione\Supporto 27

INTERVENTI

Non individuati

Anno di realizzazione						
ELEMENTI	CLASSE	SOTTOCLAS	SUPPORTO	SUB	NUMERO	DOCUM

DIAGNOSTICA E RILIEVI

Rilievo mediante drone con fotoraddrizzamenti dei prospetti esterni

Anno di realizzazione	07/2017 (contestualmente all'ispezione)					
ELEMENTI	CLASSE	SOTTOCLAS	SUPPORTO	SUB	NUMERO	DOCUM
	SV	MP	1-36			Area 6_Sup 22-23-24-25-26-27-28-29

REPORT ISPEZIONE

DENOMINAZION	LOCALITÀ	ISPEZIONE	DOCUMENT	ELEMENTO				
				Classe	Sottoclasse	Supporto	Sub	n
Castello di Arco	Arco – Via Castello 45°55'18.8"N, 10°53'16.8"E	03/07/2017	Schede tecniche	SV	MP	27		

DANNI

DISGREGAZIONE CORONAMEN

DIFFUSIONE

DESCRIZIONE

La muratura del rialzo dello spigolo Sud-Ovest ha evidenziato la caduta di un blocco del coronamento che attualmente risulta depositato sulla copertura interna.

ISTRUZIONI

Il coronamento deve essere revisionato mediante creazione di una superficie di sacrificio che consenta di allontanare le acque meteoriche con sigillatura idonea dei giunti

DOCUMENTAZIONE IMG_4498

GRAVITÀ

Il fenomeno che interessa la muratura sebbene localizzato risulta puntualmente grave.

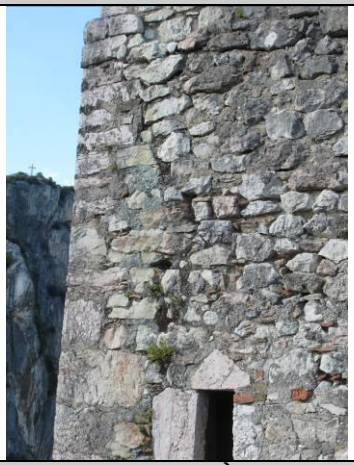
3	CONSERVATIVA	1	2	**3**
	FRUIBILITÀ	1	2	**3**
	ECONOMICA	**1**	2	3

URGENZA

Le pietre del coronamento risultano sostanzialmente non legate con possibilità di imminente caduta delle medesime.

3	CONSERVATIVA	1	2	**3**
	FRUIBILITÀ	1	2	**3**
	ECONOMICA	**1**	2	3

FESSURAZIONE / DISGREGAZI



DIFFUSIONE

DESCRIZIONE

Alcuni disgregazioni sono presenti in corrispondenza della fessura sigillata dello spigolo Nord e ne attestano la non accurata sigillatura

ISTRUZIONI

Tali disgregazioni non paiono attribuibili a movimenti attivi, ma possono costituire un problema in quanto possono costituire una via preferenziale per l'infiltrazione di acque meteoriche all'interno del corpo murario

DOCUMENTAZIONE IMG_4547

GRAVITÀ

Il fenomeno che interessa la muratura seppur diffuso non appare grave per tipologia e dimensioni delle specie.

2	CONSERVATIVA	1	**2**	3
	FRUIBILITÀ	**1**	2	3
	ECONOMICA	**1**	2	3

URGENZA

I fenomeni sono in progressione, ma non vi sono parti a rischio distacco

2	CONSERVATIVA	1	**2**	3
	FRUIBILITÀ	**1**	2	3
	ECONOMICA	**1**	2	3

REPORT ISPEZIONE

DENOMINAZIONE	LOCALITÀ	ISPEZIONE	DOCUMENTO	ELEMENTO				
				Classe	Sottoclasse	Supporto	Sub	n
Castello di Arco	Arco – Via Castello 45°55'18.8"N, 10°53'16.8"E	03/07/2017	Schede tecniche	SV	MP	27		

PROGRAMMA

AZIONI

1 — **FESSURAZIONE DISGREGAZIONE**

RISTILATURA PROFONDA DEI GIUNTI

Prospetto esterno

ATTIVITÀ	CLASSE	SOTTOC	SUPPORTO	SUB	NUM	MODALITÀ	ACCESSIBILITÀ	DATA	OPERATORE	
A	Sv	Mp	27			Lavoro	In fune	Medio termine	Operaio	OG2

2 — **DISGREGAZIONE CORONAMENTO**

REVISIONE CORONAMENTO

Coronamento

ATTIVITÀ	CLASSE	SOTTOC	SUPPORTO	SUB	NUM	MODALITÀ	ACCESSIBILITÀ	DATA	OPERATORE	
A	Sv	Mp	27			Lavoro	In fune	breve termine	Operaio	OG2

NOTE INDICAZIONI	

REPORT ISPEZIONE

DENOMINAZION	LOCALITÀ	ISPEZIONE	DOCUMENT	ELEMENTO				
				Classe	Sottoclasse	Supporto	Sub	n
Castello di Arco	Arco – Via Castello 45°55'18.8"N, 10°53'16.8"E	03/07/2017	Schede tecniche	SV	MP	28		

DESCRIZIONE

IMMAGINE

DESCRIZIONE TECNOLOGICA

Muro perimetrale Sud della torre di Laghel, dove ha sede l'attuale accesso principale. E' la più bassa delle quattro pareti della torre in quanto spicca a partire dal livello calpestabile esterno.
Il coronamento del muro non risulta; sulla sommità dello spigolo Sud-Ovest la muratura risulta più alta, in continuità con la parete Ovest, evidentemente residuo del coronamento originale della torre. La parte alta della muratura, probabilmente ricostruita per consentire l'appoggio della copertura, è realizzata in sottosquadra.

La muratura è realizzata in pietra calcarea sbozzata con posa irregolare, angoli costituiti da pietre squadrate e legata da malta di calce con inerti da millimetrici a centimetrici. La sigillatura delle fughe (sebbene attualmente degradata) risulta in origine molto alta a creare una superficie regolare.

STATO DI CONSERVAZIONE GENERALE:
La muratura non mostra sconnessioni ad eccezione del rialzo sulla sommità che presenta fessurazioni verticali; il coronamento ha già mostrato cadute di materiale.

Anno di realizzazione	Non noto
Documentazione fotografica ispezione	..\..\0_Documentazione fotografica ispezione\Supporto 28

INTERVENTI

Non individuati

Anno di realizzazione						
ELEMENTI	CLASSE	SOTTOCLAS	SUPPORTO	SUB	NUMERO	DOCUM

DIAGNOSTICA E RILIEVI

Rilievo mediante drone con fotoraddrizzamenti dei prospetti esterni

Anno di realizzazione	07/2017 (contestualmente all'ispezione)					
ELEMENTI	CLASSE	SOTTOCLAS	SUPPORTO	SUB	NUMERO	DOCUM
	SV	MP	1-36			Area 6_Sup 22-23-24-25-26-27-28-29

REPORT ISPEZIONE

DENOMINAZIONE	LOCALITÀ	ISPEZIONE	DOCUMENTO	ELEMENTO				
				Classe	Sottoclasse	Supporto	Sub	n
Castello di Arco	Arco – Via Castello 45°55'18.8"N, 10°53'16.8"E	03/07/2017	Schede tecniche	SV	MP	28		

DANNI

FESSURAZIONI

DIFFUSIONE

DESCRIZIONE

La muratura sulla sommità della parete presenta fessurazioni verticali parallele.
Tali fessurazioni evidenziano la disgregazione strutturale di tale muratura alla quale deve essere correlata alla caduta di un blocco sul lato interno (vedi scheda 27).

ISTRUZIONI

Le fessurazioni devono essere sigillate.

DOCUMENTAZIONE IMG_4545

GRAVITÀ

Il fenomeno che interessa la muratura sebbene localizzato risulta puntualmente grave in quanto questa muratura prospetta sul sottostante percorso aperto al pubblico.

3	CONSERVATIVA	1	2	3
	FRUIBILITÀ	1	2	**3**
	ECONOMICA	1	2	3

URGENZA

Le pietre risultano non legate con possibilità di caduta delle medesime nell'immediato.

3	CONSERVATIVA	1	2	**3**
	FRUIBILITÀ	1	2	**3**
	ECONOMICA	1	2	3

DISTACCO BLOCCHI CORONAM

DIFFUSIONE

DESCRIZIONE

La muratura del rialzo dello spigolo Sud-Ovest ha evidenziato la caduta di un blocco del coronamento che attualmente risulta depositato sulla copertura interna.

ISTRUZIONI

Il coronamento deve essere revisionato mediante creazione di una superficie di sacrificio che consenta di allontanare le acque meteoriche con sigillatura idonea dei giunti

DOCUMENTAZIONE
IMG_4498

GRAVITÀ

Il fenomeno è lo stesso segnalato nella scheda 27; sebbene localizzato risulta puntualmente grave in quanto questo spigolo prospetta sul sottostante percorso aperto al pubblico.

3	CONSERVATIVA	1	2	**3**
	FRUIBILITÀ	1	2	**3**
	ECONOMICA	1	2	3

URGENZA

Le pietre del coronamento risultano sostanzialmente non legate con possibilità di imminente caduta delle medesime.

3	CONSERVATIVA	1	2	**3**
	FRUIBILITÀ	1	2	**3**
	ECONOMICA	1	2	3

REPORT ISPEZIONE

DENOMINAZIONE	LOCALITÀ	ISPEZIONE	DOCUMENTO	ELEMENTO				
				Classe	Sottoclasse	Supporto	Sub	n
Castello di Arco	Arco – Via Castello 45°55'18.8"N, 10°53'16.8"E	03/07/2017	Schede tecniche	SV	MP	28		

PROGRAMMA

AZIONI		

RISTILATURA PROFONDA DEI GIUNTI

Prospetto esterno

		ATTIVITÀ	CLASSE	SOTTOC	SUPPORTO	SUB	NUM	MODALITÀ	ACCESSIBILITÀ	DATA	OPERATORE	
1	FESSURAZION	A	Sv	Mp	28			Lavoro	In fune	breve termine	Operaio	OG2

REVISIONE CORONAMENTO

Coronamento

		ATTIVITÀ	CLASSE	SOTTOC	SUPPORTO	SUB	NUM	MODALITÀ	ACCESSIBILITÀ	DATA	OPERATORE	
2	DISGREGAZIO CORONAMENT	A	Sv	Mp	28			Lavoro	In fune	breve termine	Operaio	OG2

NOTE INDICAZIONI	

REPORT ISPEZIONE

DENOMINAZION	LOCALITÀ	ISPEZIONE	DOCUMENT	ELEMENTO				
				Classe	Sottoclasse	Supporto	Sub	n
Castello di Arco	Arco – Via Castello 45°55'18.8"N, 10°53'16.8"E	03/07/2017	Schede tecniche	SV	MP	29		

DESCRIZIONE

IMMAGINE

DESCRIZIONE TECNOLOGICA

Muratura la cui funzione è difficilmente interpretabile che spicca dallo spigolo Nord-Est della torre del Laghel nella posizione maggiormente strapiombante. Tale muratura non è ammorsata allo spigolo della torre (vedi immagine sopra). E' fondata direttamente sulla roccia affiorante ed a valle c'è una fune di acciaio trasversale, forse utilizzata per scopi manutentivi.

La muratura è realizzata in pietra calcarea sbozzata con posa irregolare, angoli parzialmente costituiti da pietre squadrate e legata da malta di calce con inerti da millimetrici a centimetrici. La fugatura in malta di calce molto alta a creare una superficie regolare.
Esposizione Nord-Sud

STATO DI CONSERVAZIONE GENERALE:
Lo stato di conservazione è buono, ad eccezione del coronamento che si presenta degradato con distacco di singoli blocchi in pietra. Il piede appare ben appoggiato sulla roccia direttamente affiorante.

Anno di realizzazione	Non noto
Documentazione fotografica ispezione	..\..\0_Documentazione fotografica ispezione\Supporto 29

INTERVENTI

Non individuati

Anno di realizzazione						
ELEMENTI	CLASSE	SOTTOCLAS	SUPPORTO	SUB	NUMERO	DOCUM

DIAGNOSTICA E RILIEVI

Rilievo mediante drone con fotoraddrizzamenti dei prospetti esterni

Anno di realizzazione	07/2017 (contestualmente all'ispezione)					
ELEMENTI	CLASSE	SOTTOCLAS	SUPPORTO	SUB	NUMERO	DOCUM
	SV	MP	1-36			Area 6_Sup 22-23-24-25-26-27-28-29

REPORT ISPEZIONE

DENOMINAZIONE	LOCALITÀ	ISPEZIONE	DOCUMENTO	ELEMENTO				
				Classe	Sottoclasse	Supporto	Sub	n
Castello di Arco	Arco – Via Castello 45°55'18.8"N, 10°53'16.8"E	03/07/2017	Schede tecniche	SV	MP	29		

DANNI

DISGREGAZIONE CORONAMEN

DIFFUSIONE

DESCRIZIONE

Il coronamento della muratura appare sensibilmente disgregato, con mancanza di malta nei giunti; i blocchi risultano quindi malamente ammorsati.

ISTRUZIONI

Il coronamento deve essere revisionato mediante creazione di una superficie di sacrificio che consenta di allontanare le acque meteoriche con sigillatura idonea dei giunti.

DOCUMENTAZIONE IMG_4510

GRAVITÀ					URGENZA				
Vista la posizione strapiombante della muratura la caduta dei blocchi può coinvolgere il territorio sottostante.					Il coronamento alla sommità della muratura non ha protezione per cui i fenomeni di degrado progrediscono.				
2	**CONSERVATIVA**	1	2	3	**2**	**CONSERVATIVA**	1	2	3
	FRUIBILITÀ	1	2	3		**FRUIBILITÀ**	1	2	3
	ECONOMICA	1	2	3		**ECONOMICA**	1	2	3

REPORT ISPEZIONE

DENOMINAZION	LOCALITÀ	ISPEZIONE	DOCUMENTO	ELEMENTO				
				Classe	Sottoclasse	Supporto	Sub	n
Castello di Arco	Arco – Via Castello 45°55'18.8"N, 10°53'16.8"E	03/07/2017	Schede tecniche	SV	MP	29		

PROGRAMMA

AZIONI	

REVISIONE CORONAMENTO

Coronamento

		ATTIVITÀ	CLASSE	SOTTOC	SUPPORTO	SUB	NUM	MODALITÀ	ACCESSIBILI	DATA	OPERATORE	
1	DISGREGAZIO CORONAMENT	A	Sv	Mp	29			Lavoro	In fune	Medio termine	Operaio	OG2

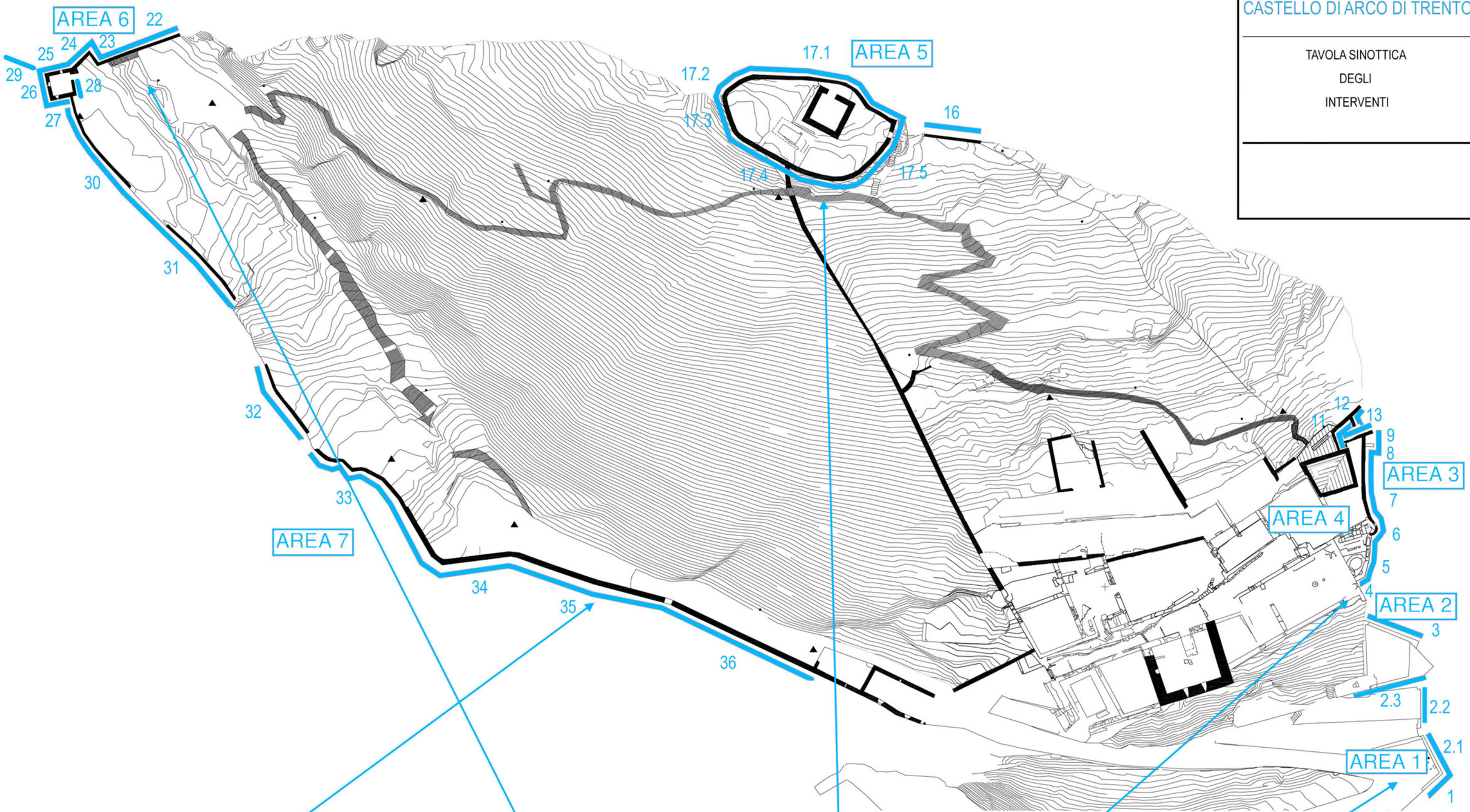
NOTE INDICAZIONI	

FOPPOLI MORETTA e ASSOCIATI
società di ingegneria

FAARCHITETTO
SERVIZI PER LA CONSERVAZIONE DEL PATRIMONIO

CASTELLO DI ARCO DI TRENTO

TAVOLA SINOTTICA
DEGLI
INTERVENTI



COD.	DANNO	SUPPORTO																																	
		36	35	34	33	32	30	29	28	27	26	25	24	23	22	17.5	17.4	17.3	17.2	17.1	16	12 e 13	11	8 e 9	7	6	5	4	3	2.3	2.2	2.1	1
RibS	Ribaltamento spigolo																																
ManAp	Mancanza di appoggio al piede																																
Man	Mancanza																																
ColB	Colonizzazione biologica																																
Disg	Disgregazione giunti di malta																																
Cor	Disgregazione e coronamento																																
Fes	Fessurazione																																

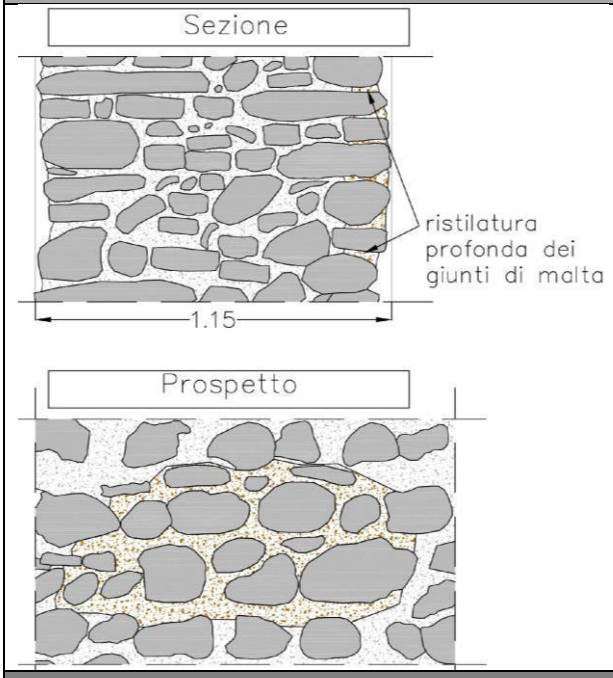
REPORT ISPEZIONE

DENOMINAZIONE	LOCALITÀ	ISPEZIONE	DOCUMENTO			Intervento	
Castello di Arco	Arco – Via Castello 45°55'18.8"N, 10°53'16.8"E	04/07/2017	Anagrafica del bene				A

DANNO: DISGREGAZIONE DEI GIUNTI DI MALTA

IMMAGINE	DESCRIZIONE TECNOLOGICA
	Fenomeni di disgregazione della malta nei giunti. Tali fenomeni non paiono attribuibili a movimenti attivi, ma possono rappresentare un problema in quanto costituiscono una via preferenziale per l'infiltrazione di acque meteoriche all'interno del corpo murario.

INTERVENTO: RISTILATURA PROFONDA DEI GIUNTI

SCHEMA INTERVENTO	PROCEDURA DI INTERVENTO
	1) Scarifica per 10/15 cm del giunto, evitando di rimuovere tutta la malta, con utilizzo di attrezzatura a sola rotazione in modo da non causare vibrazioni alla struttura; 2) Rifinitura della rimozione a mano con scalpello e/o cazzuola e pulizia accurata con aria compressa per rimuovere il velo di malta residuo; 3) Verifica della correttezza della profondità di scarifica con misure a campione; 4) Lavaggio con acqua per evitare i residui pulverulenti della malta e per idratare la malta esistente; 5) Ristilatura in profondità della malta all'interno dei giunti mediante malta applicata a cazzuola oppure mediante apparecchiatura di estrusione idonea per la granulometria della malta stessa - adagiare bene sul fondo del giunto le prime quantità di malta per farle aderire agli strati più profondi preesistenti ed alla pietra; 6) Attendere almeno mezz'ora per consentire il raggiungimento di una sufficiente plasticità ed evitare il rifluimento della malta e quindi procedere ad un'ulteriore ristilatura più superficiale.
COSTO	**MATERIALI**
115 €/m² Esclusi: - spese tecniche di prog/DL - opere provvisionali - oneri della sicurezza	• **MALTE A BASE DI CALCE** Inerti con tipologia e granulometria opportunamente raccordate con l'originale;

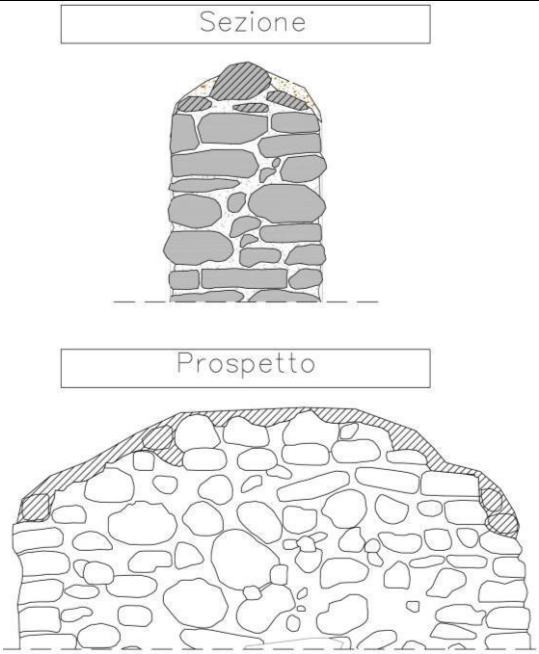
REPORT ISPEZIONE

DENOMINAZIONE	LOCALITÀ	ISPEZIONE	DOCUMENTO			Intervento	
Castello di Arco	Arco – Via Castello 45°55'18.8"N, 10°53'16.8"E	04/07/2017	Anagrafica del bene				B

DANNO: DISGREGAZIONE CORONAMENTO

IMMAGINE	DESCRIZIONE TECNOLOGICA
	Il coronamento della muratura appare sensibilmente disgregato, con mancanza di malta nei giunti; alcuni blocchi risultano quindi poco o per niente ammorsati ed a rischio di caduta.

INTERVENTO: REVISIONE CORONAMENTO E REALIZZAZIONE SUPERFI SACRIFICIO

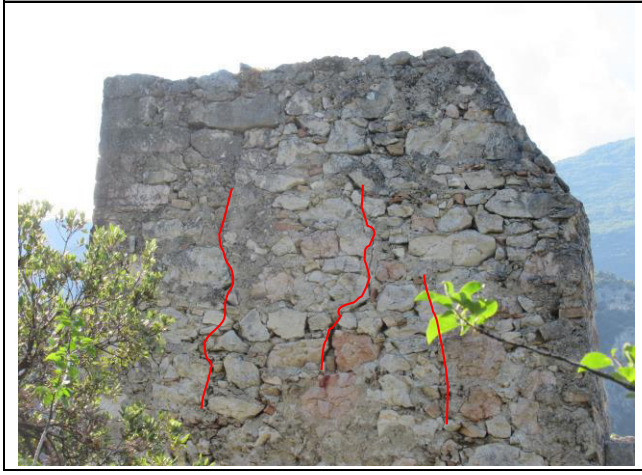
SCHEMA INTERVENTO	PROCEDURA DI INTERVENTO
	Revisione del coronamento mediante il fissaggio dei blocchi instabili, e realizzazione di giunti e scivoli in malta atti al corretto deflusso delle acque meteoriche. Utilizzare malte a base di calce e inerti con tessitura e granulometria opportunamente raccordate con l'originale, con totale esclusione di cemento.

COSTO	MATERIALI
285 €/m² Esclusi: - spese tecniche di prog/DL - opere provvisionali - oneri della sicurezza	• **MALTE A BASE DI CALCE** e inerti con tipologia e granulometria opportunamente raccordate con l'originale; • **PIETRE DI RECUPERO** conformi per dimensione e litologia a quelle presenti nel paramento

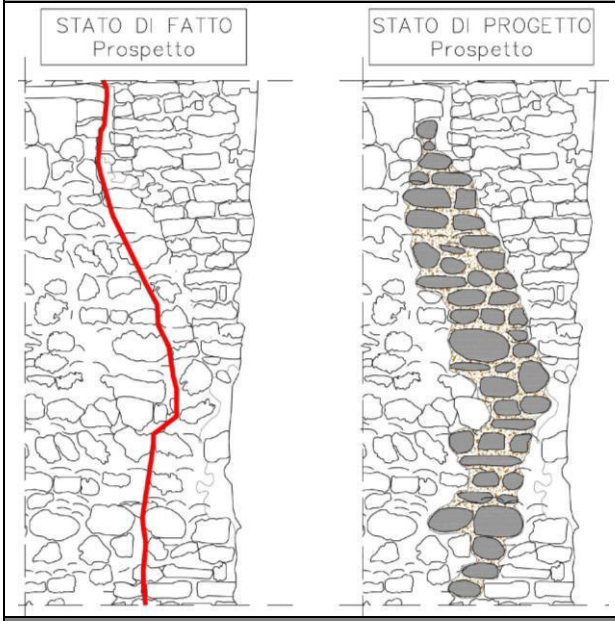
REPORT ISPEZIONE

DENOMINAZIONE	LOCALITÀ	ISPEZIONE	DOCUMENTO				
Castello di Arco	Arco – Via Castello 45°55'18.8"N, 10°53'16.8"E	04/07/2017	Anagrafica del bene			Intervento	C

DANNO: FESSURAZIONI

IMMAGINE	DESCRIZIONE TECNOLOGICA
	Fessurazioni verticali parallele che evidenziano la disgregazione strutturale della muratura.

INTERVENTO: CONSOLIDAMENTO MEDIANTE TECNICA DEL CUCI-SCUC

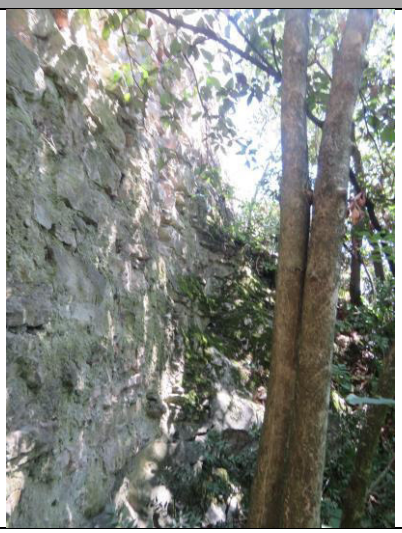
SCHEMA INTERVENTO	PROCEDURA DI INTERVENTO
	1) Delimitazione della parte di muratura da sostituire ed individuazione dei cantieri successivi che dovranno essere alternati in modo da poter sempre disporre di una sezione sufficiente di muratura resistente; 2) Eventuale puntellazione della porzione di muratura sovrastante la zona di intervento; 3) Rimozione, eseguita con attrezzi manuali, del cantiere di muratura individuato fino al contorno reputato sano; 4) Lavaggio con acqua per evitare i residui pulverulenti della malta e per idratare la malta esistente; 5) Ricostruzione di nuova apparecchiatura muraria, ad esclusione dell'ultimo filare, utilizzando malte a base di calce, curando particolarmente l'ammorsamento laterale con la muratura esistente; 6) Forzatura della nuova muratura con la sovrastante esistente mediante l'inserimento di cunei di legno da controllare e sostituire, a ritiro avvenuto, con pietrame e malta a ritiro compensato fino al corretto riempimento degli spazi.

COSTO	MATERIALI
520 €/m^3 Esclusi: - spese tecniche di prog/DL - opere provvisionali - oneri della sicurezza	• **MALTE A BASE DI CALCE** inerti con tipologia e granulometria opportunamente raccordate con l'originale; • **PIETRE DI RECUPERO** conformi per dimensione e litologia a quelle presenti nel paramento

REPORT ISPEZIONE

DENOMINAZIONE	LOCALITÀ	ISPEZIONE	DOCUMENTO				
	Arco – Via Castello 45°55'18.8"N, 10°53'16.8"E	04/07/2017	Anagrafica del bene			Intervento	
Castello di Arco							I

DANNO: PRESENZA DI VEGETAZIONE

IMMAGINE	DESCRIZIONE TECNOLOGICA
	La presenza di vegetazione soprattutto di tipo arbustivo si localizza in particolare nei prospetti esterni al piede delle muratura o direttamente negli interstizi murari. La vegetazione a portamento arbustivo crea disarticolazione delle murature per la crescita degli apparati radicali

INTERVENTO: TRATTAMENTO BIOCIDA E SUCCESSIVA ASPORTAZIONE VEGETAZIONE _SPECIE ARBUSTIVE CRESCIUTE AL PIEDE DELLA MURA

SCHEMA INTERVENTO	PROCEDURA DI INTERVENTO
	1_Taglio a raso degli arbusti con mezzi meccanici a bassa vibrazione senza procedere all'estirpazione della ceppaia. 2_Devitalizzazione della ceppaia mediante iniezione di diserbante liquido (tipo Picloram) da effettuarsi nel periodo vegetativo previa realizzazione di opportuni fori ottenuti con trapano al fine di raggiungere i vasi conduttori (trachee). 3_Ad avvenuta devitalizzazione ,rimozione della ceppaia

COSTO

150€/cad
Esclusi

- spese tecniche di prog/DL
- opere provvisionali
- oneri della sicurezza

REPORT ISPEZIONE							
DENOMINAZIONE	**LOCALITÀ**	**ISPEZIONE**	**DOCUMENTO**				
Castello di Arco	Arco – Via Castello 45°55'18.8"N, 10°53'16.8"E	04/07/2017	Anagrafica del bene			Intervento	J

DANNO: PRESENZA DI VEGETAZIONE

IMMAGINE	DESCRIZIONE TECNOLOGICA
	La presenza di vegetazione soprattutto di tipo arbustivo si localizza in particolare nei prospetti esterni al piede delle muratura dove il deposito di semi e terricci oconsente la formazione di arbusti.

INTERVENTO: CREAZIONE DI SCIVOLO DI MALTA

SCHEMA INTERVENTO	PROCEDURA DI INTERVENTO
	1_Pulizia dell'area, precedentemente ripulita dalla presenza di arbusti, con asportazione depositi incoerenti mediante scope, spazzole, bisturi, ed aspiratori 2_lavaggio mediante idropulitrice 3_ stesura di copertina/scivolo di malta con inerti di granulometria fino a 2 cm

COSTO

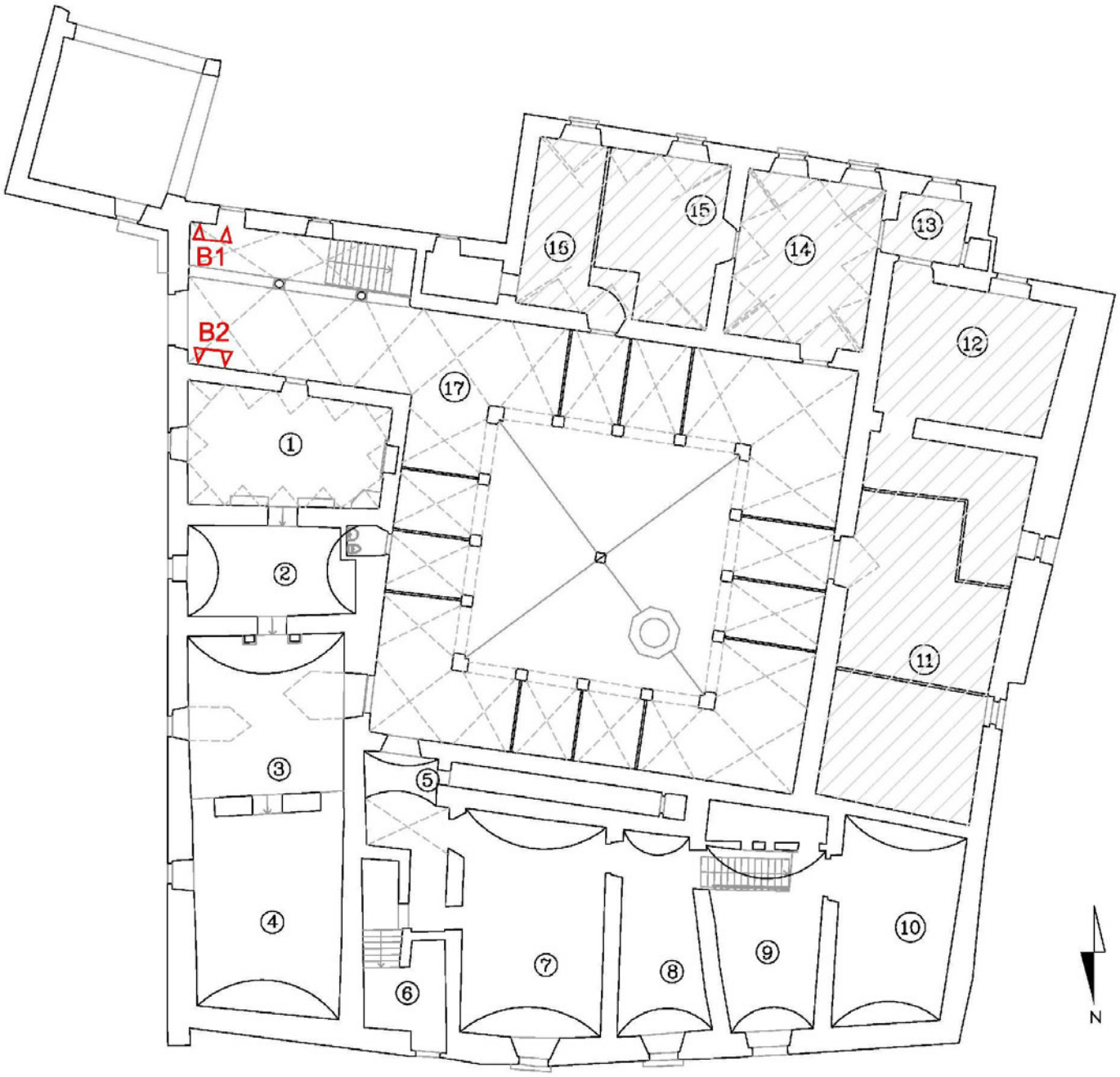
75€/mq
Esclusi

- spese tecniche di prog/DL
- opere provvisionali
- oneri della sicurezza

ANNEX 18

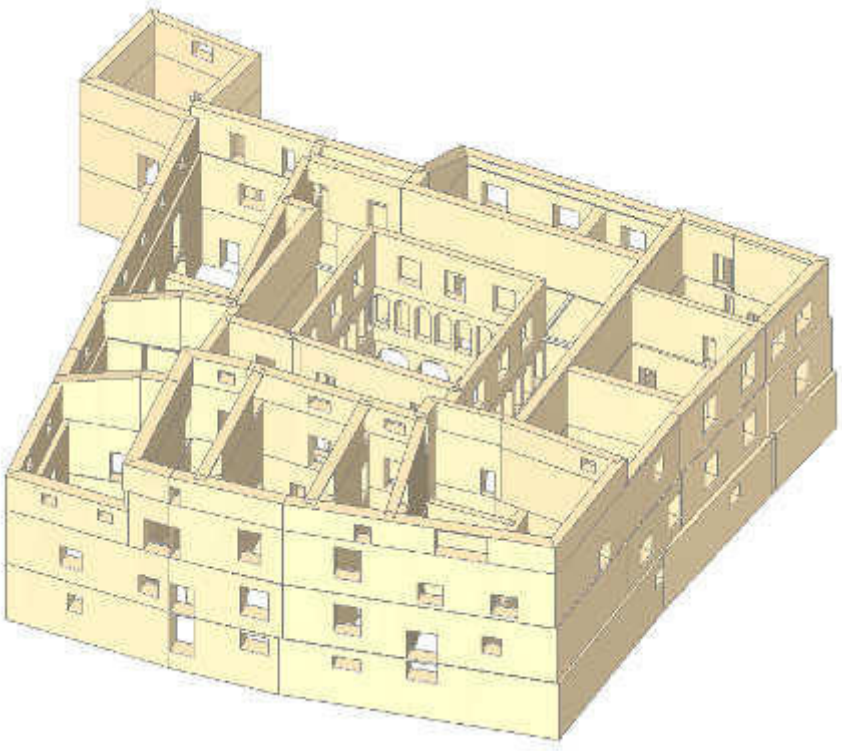
CASE STUDIES N. 6: SEISMIC VULNERABILITY - SAFETY FOR SEISMIC EVENTS
Cascina Monastero in Castelseprio (Varese) and Besta Palace in Teglio (Sondrio)

PIANTA PIANO TERRA



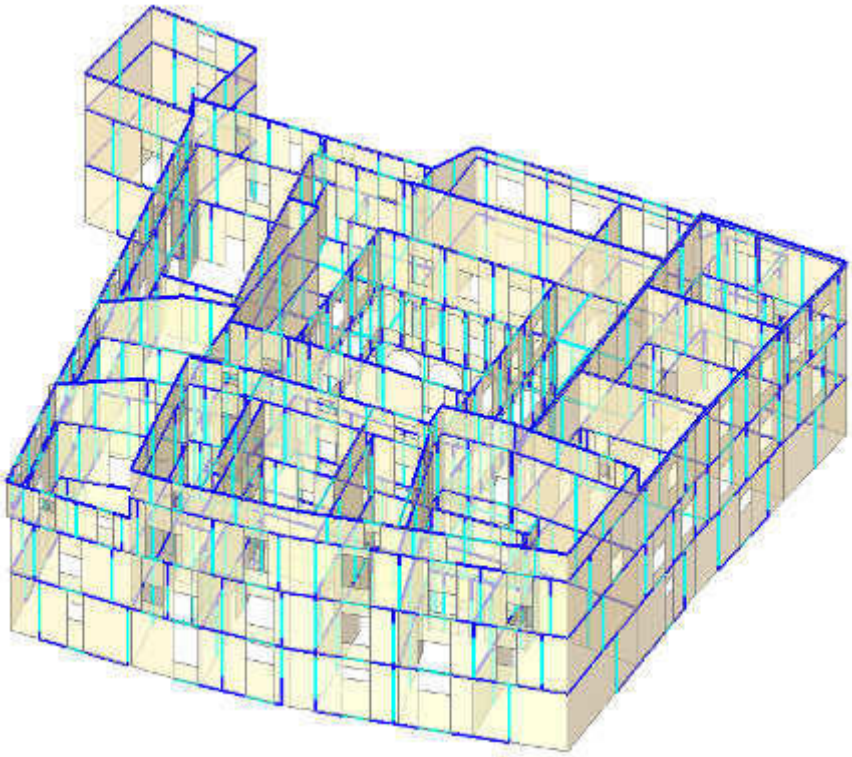
Creazione modello architettonico di base

-Vista Nord-Ovest-

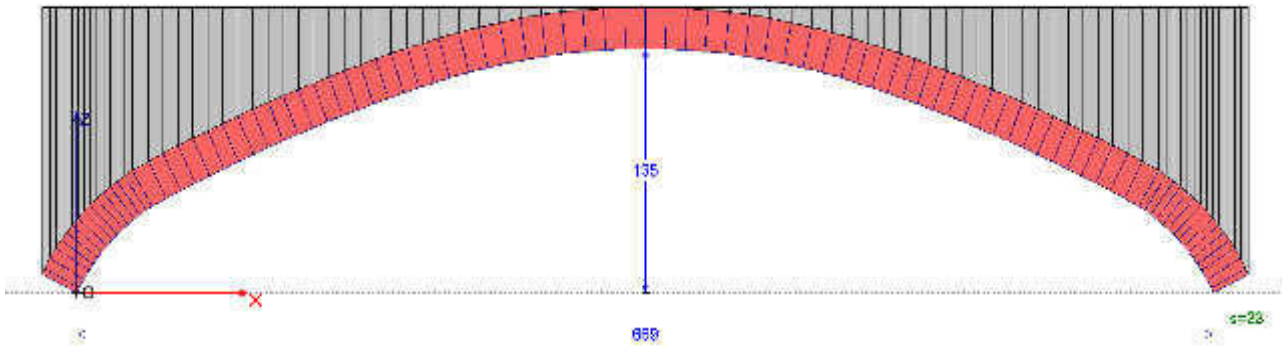


Modellazione elementi strutturali

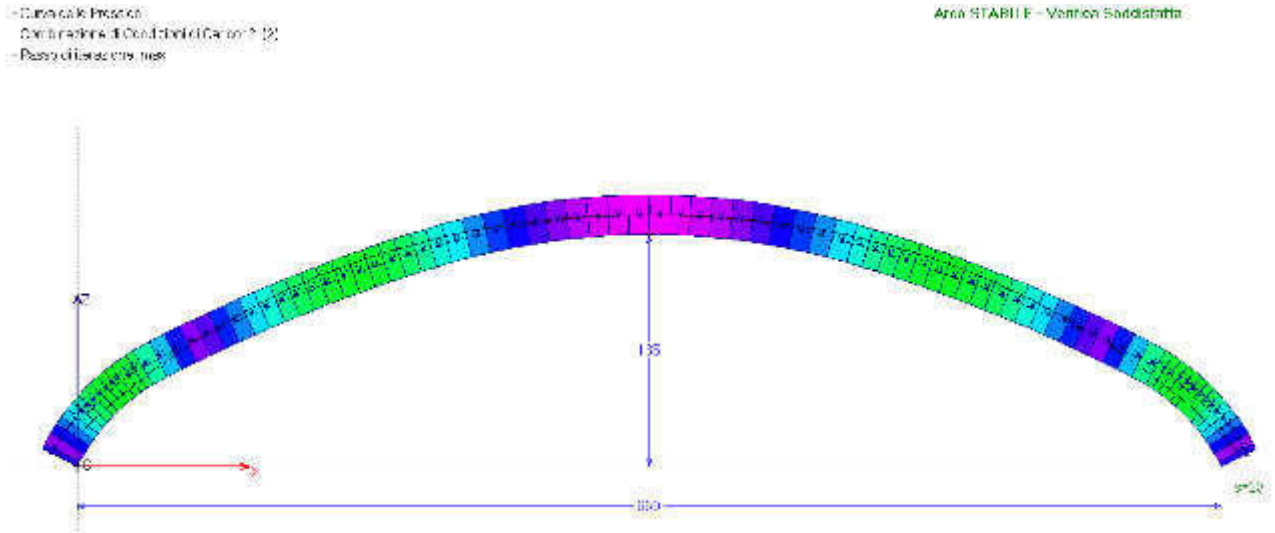
-Vista Nord-Ovest-



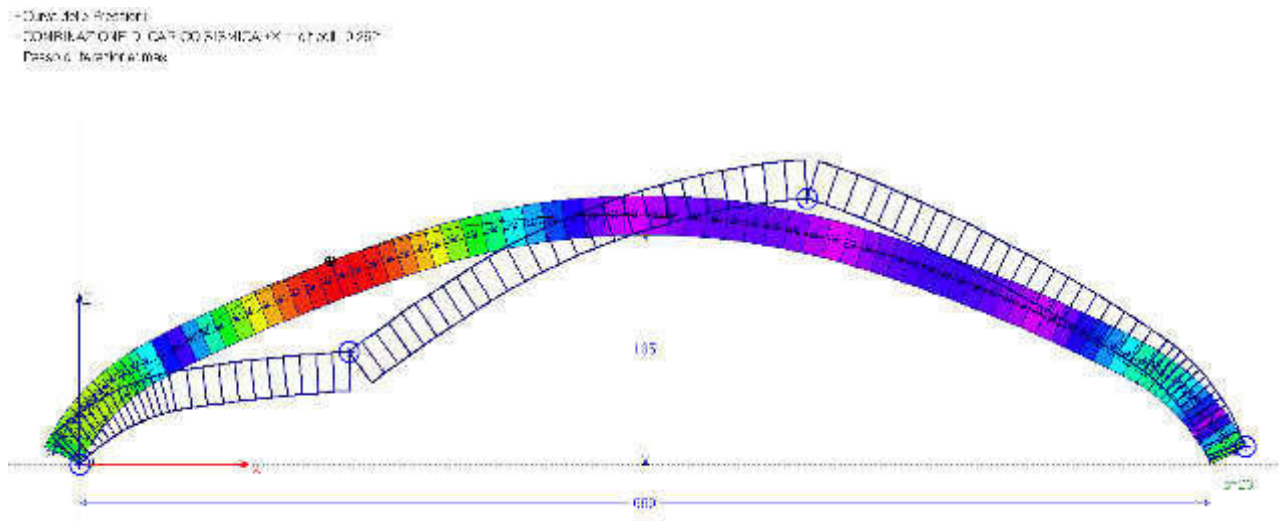
Sezione di calcolo della volta



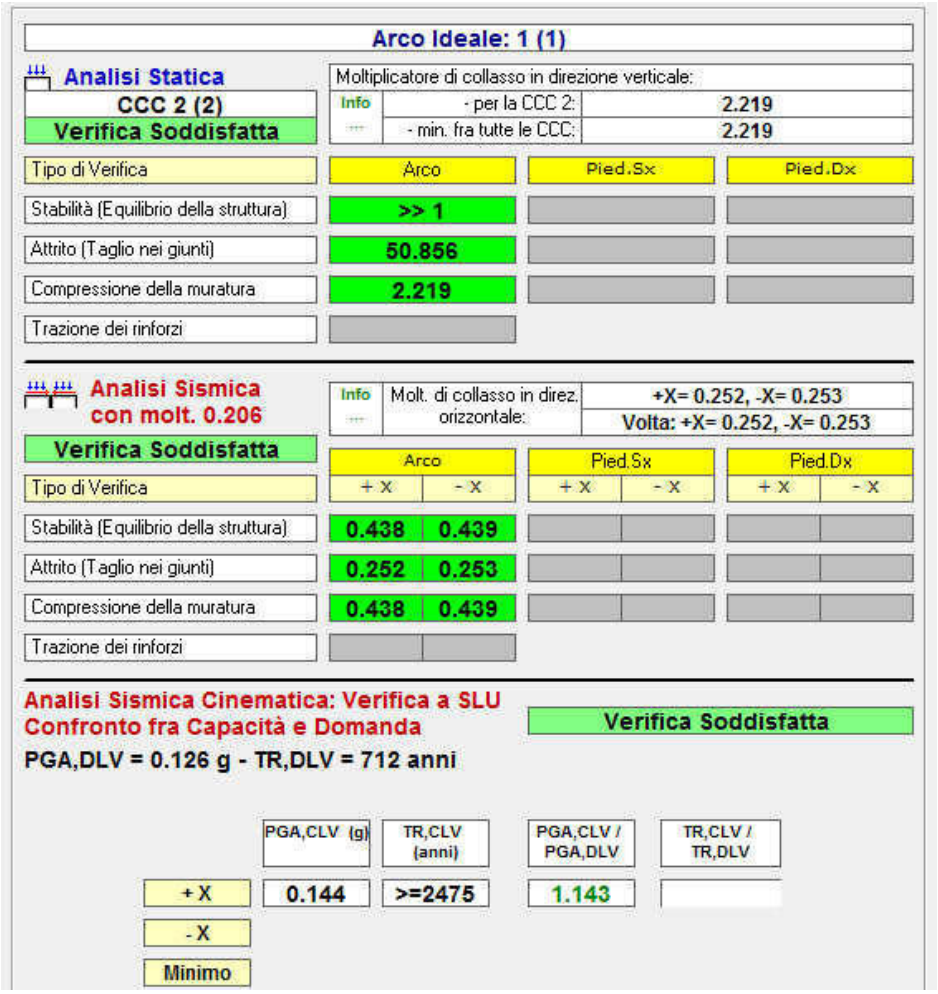
Sezione di calcolo della volta – Curva delle pressione – Condizione di carico: distribuito uniforme



Sezione di calcolo volta – Curva delle pressione e cinematismo di collasso direzione X^+ – Condizione di carico: distribuito uniforme



Sintesi moltiplicatori a collasso ed Indicatori di Rischio Sismico



Arco Ideale: 1 (1)

Analisi Statica

CCC 2 (2)

Verifica Soddisfatta

Moltiplicatore di collasso in direzione verticale:

Info

- per la CCC 2: 2.219
- min. fra tutte le CCC: 2.219

Tipo di Verifica	Arco	Pied.Sx	Pied.Dx
Stabilità (Equilibrio della struttura)	>> 1		
Attrito (Taglio nei giunti)	50.856		
Compressione della muratura	2.219		
Trazione dei rinforzi			

Analisi Sismica con molt. 0.206

Verifica Soddisfatta

Info

Molt. di collasso in direz. orizzontale: +X= 0.252, -X= 0.253

Volta: +X= 0.252, -X= 0.253

Tipo di Verifica	Arco		Pied.Sx		Pied.Dx	
	+ X	- X	+ X	- X	+ X	- X
Stabilità (Equilibrio della struttura)	0.438	0.439				
Attrito (Taglio nei giunti)	0.252	0.253				
Compressione della muratura	0.438	0.439				
Trazione dei rinforzi						

Analisi Sismica Cinematica: Verifica a SLU

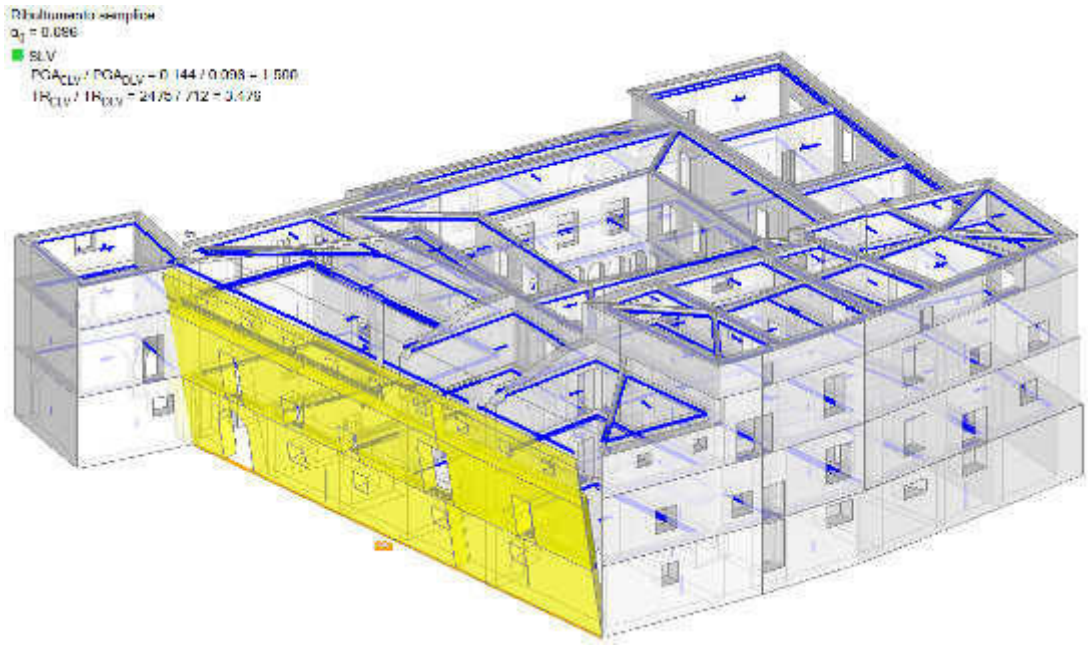
Confronto fra Capacità e Domanda

Verifica Soddisfatta

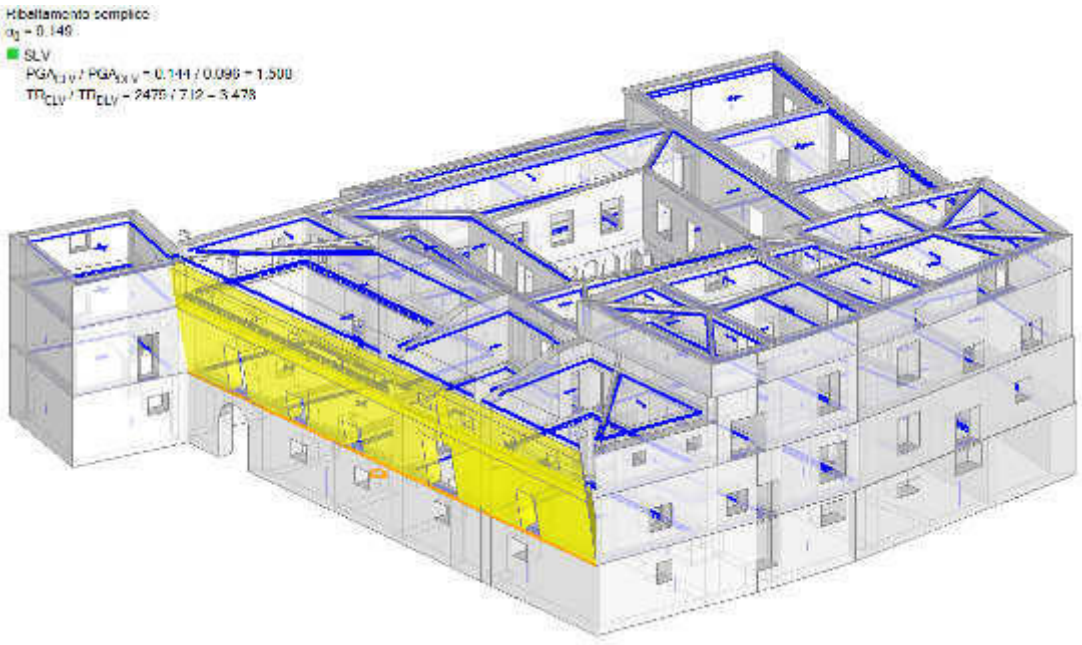
PGA,DLV = 0.126 g - TR,DLV = 712 anni

	PGA,CLV (g)	TR,CLV (anni)	PGA,CLV / PGA,DLV	TR,CLV / TR,DLV
+ X	0.144	>=2475	1.143	
- X				
Minimo				

A)RIBALTAMENTO FACCIATA EST GLOBALE – CERNIERA 1 AL PT-



A)RIBALTAMENTO FACCIATA EST GLOBALE – CERNIERA 2 AL P1-



RISULTATI MECCANISMI LOCALI DI COLLASSO

MECCANISMO DI RIBALTAMENTO	IRS_{PGA}	IRS_{TR}
a) facciata Est globale rispetto:		
cerniera 1 (P.T.)	> 1.500	> 3.476
cerniera 2 (P.1)	> 1.500	> 3.476
cerniera 3 (P.2)	> 1.500	> 3.476
b) facciata Nord parziale rispetto alla cerniera:		
cerniera 1 (P.T.)	1.323	2.374
cerniera 2 (P.1)	> 1.500	> 3.476
cerniera 3 (P.2)	> 1.500	> 3.476
cerniera 4 (P.3)	> 1.500	> 3.476
c) facciata Ovest parziale:		
cerniera 1 (P.T.)	> 1.500	> 3.476
cerniera 2 (P.1)	> 1.500	> 3.476
cerniera 3 (P.2)	> 1.500	> 3.476
d) facciata Sud-Ovest parziale:		
cerniera 1 (P.T.)	> 1.500	> 3.476
cerniera 2 (P.1)	> 1.500	> 3.476
cerniera 3 (P.2)	> 1.500	> 3.476
e) facciata Sud-Est rispetto alla cerniera:		
cerniera 1 (P.T.)	**0.885**	**0.726**
cerniera 2 (P.1)	> 1.500	> 3.476
cerniera 3 (P.2)	> 1.500	> 3.476
f) facciata Est parziale:		
cerniera 1 (P.T.)	> 1.500	> 3.476
cerniera 2 (P.1)	> 1.500	> 3.476
cerniera 3 (P.2)	> 1.500	> 3.476
g) facciata sud loggiato:		
cerniera 3 (P.2)	> 1.500	> 3.476
h) facciata Nord loggiato:		
cerniera 3 (P.2)	> 1.500	> 3.476
i) facciata Ovest loggiato:		
cerniera 3 (P.2)	> 1.500	> 3.476

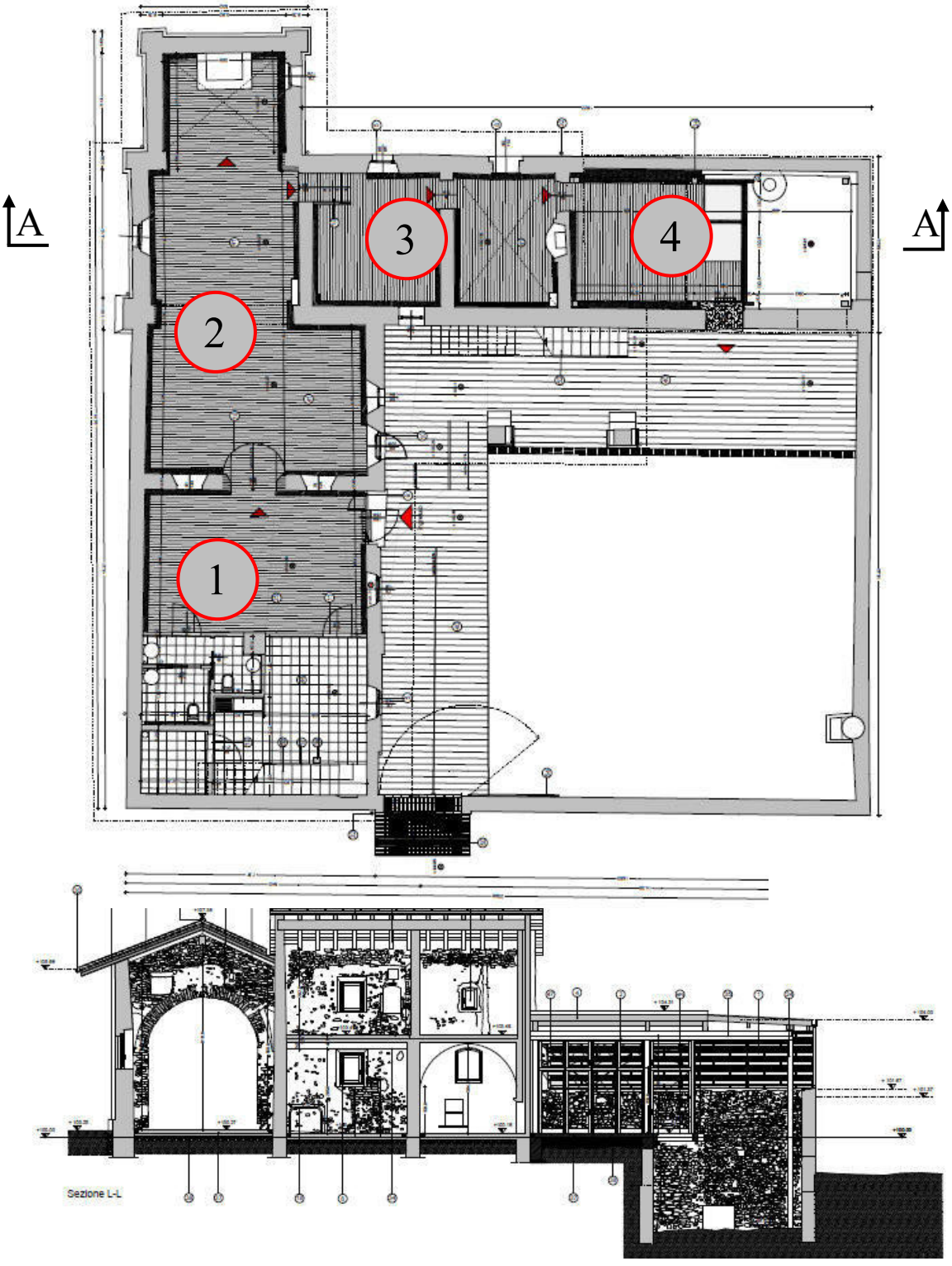


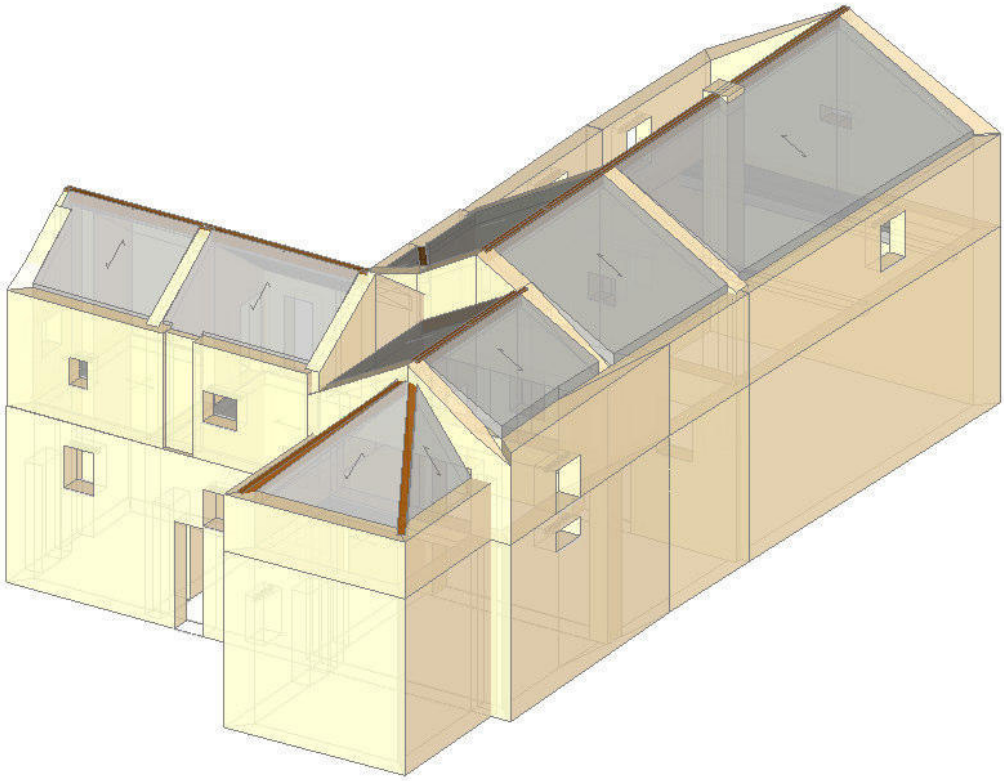
Fig. 2 Planimetria piano terra e sezione trasversale A-A

3.2.2. Fondazioni

Non sono disponibili indicazioni relative alla quota di imposta ed alla geometria delle fondazioni; in base al raffronto con edifici similari si può ipotizzare che il piano di imposta delle fondazioni risulti poco al di sotto della quota di pavimento del piano terra.

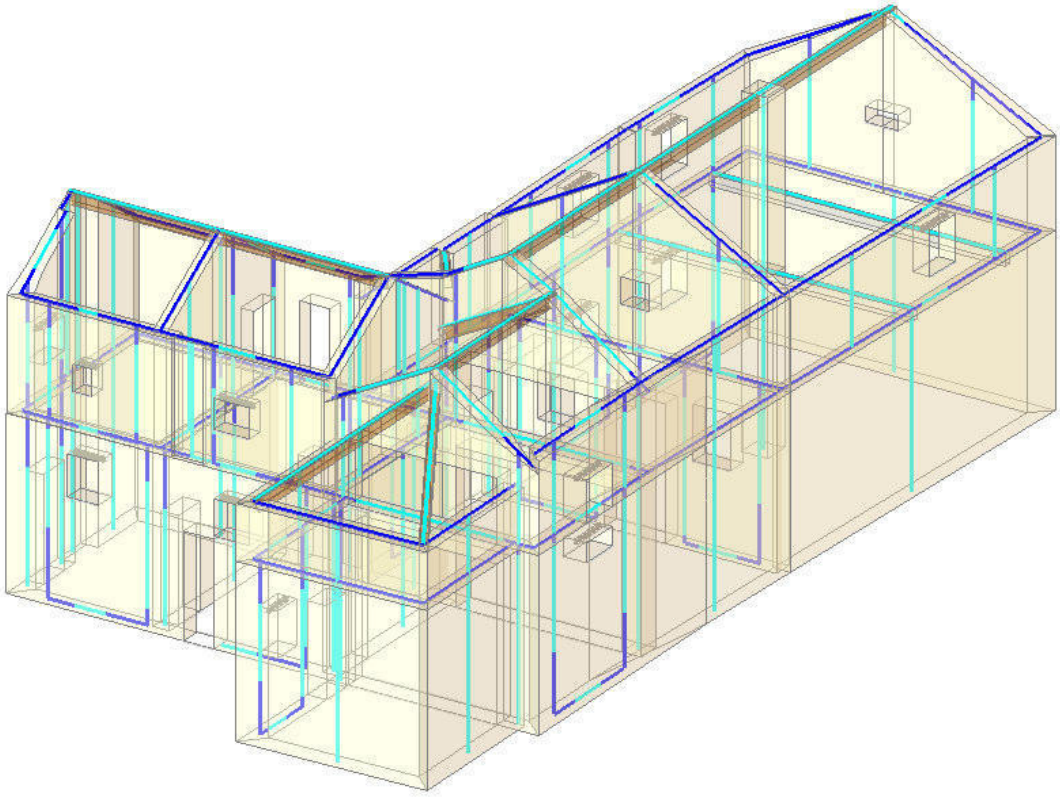
Creazione modello architettonico di base

-Vista Nord-Est-



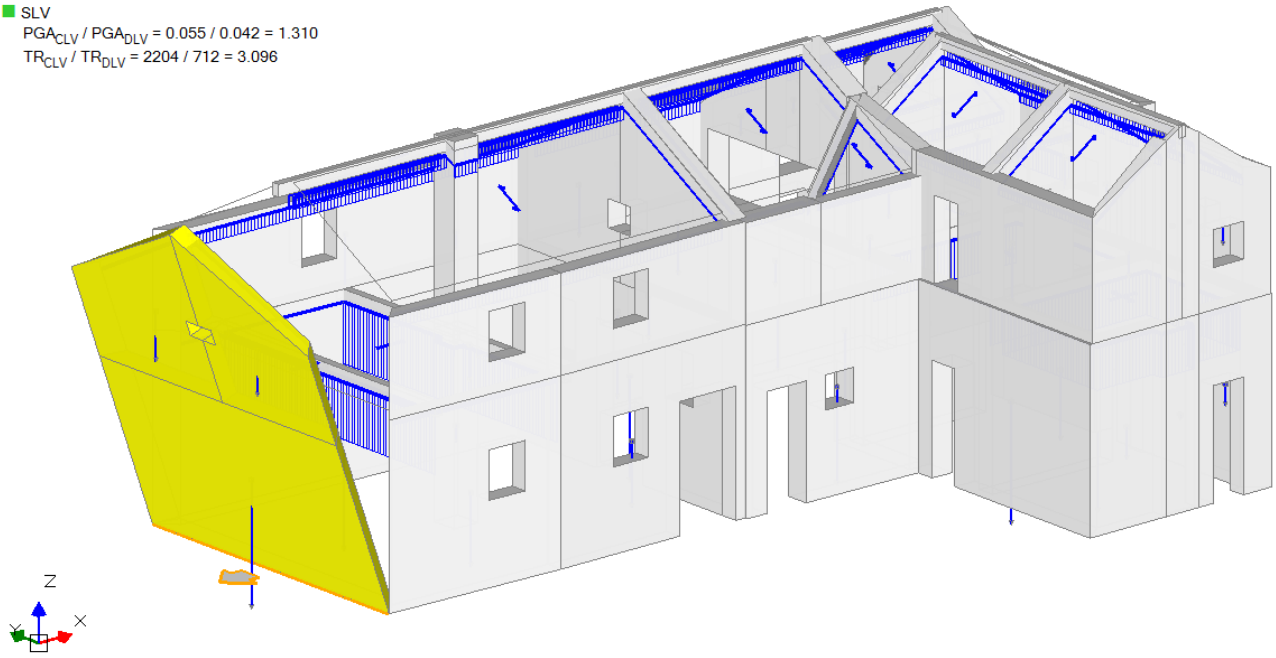
Modellazione elementi strutturali

-Vista Nord-Est-



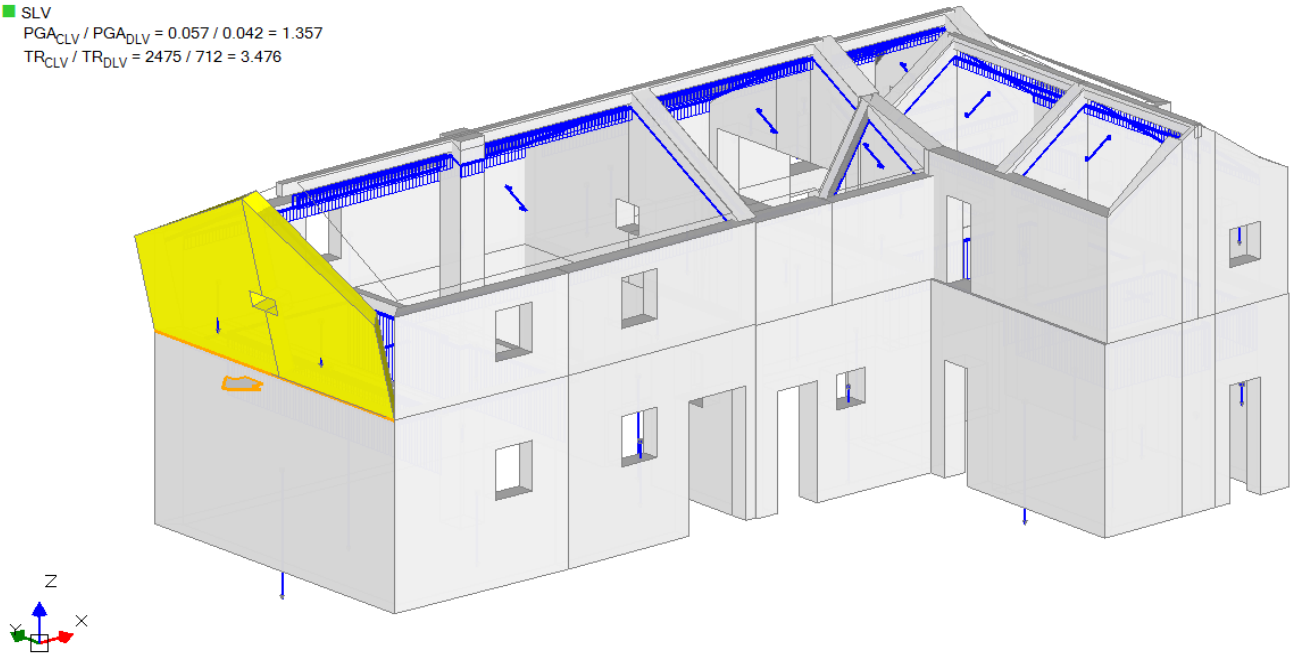
a) RIBALTAMENTO FACCIATA OVEST GLOBALE – CERNIERA 1 AL PT-

01. Ribaltamento Ovest
Ribaltamento semplice
α_0 = 0.054
SLV
PGA_{CLV} / PGA_{DLV} = 0.055 / 0.042 = 1.310
TR_{CLV} / TR_{DLV} = 2204 / 712 = 3.096



a) RIBALTAMENTO FACCIATA OVEST GLOBALE – CERNIERA 2 AL P1-

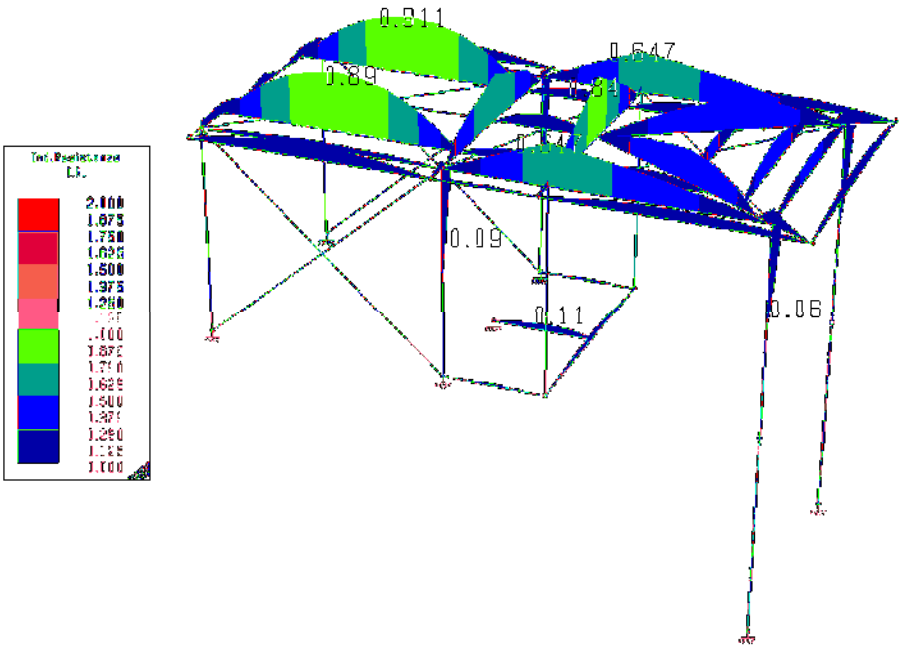
02. Ribaltamento Ovest 2
Ribaltamento semplice
α_0 = 0.121
SLV
PGA_{CLV} / PGA_{DLV} = 0.057 / 0.042 = 1.357
TR_{CLV} / TR_{DLV} = 2475 / 712 = 3.476



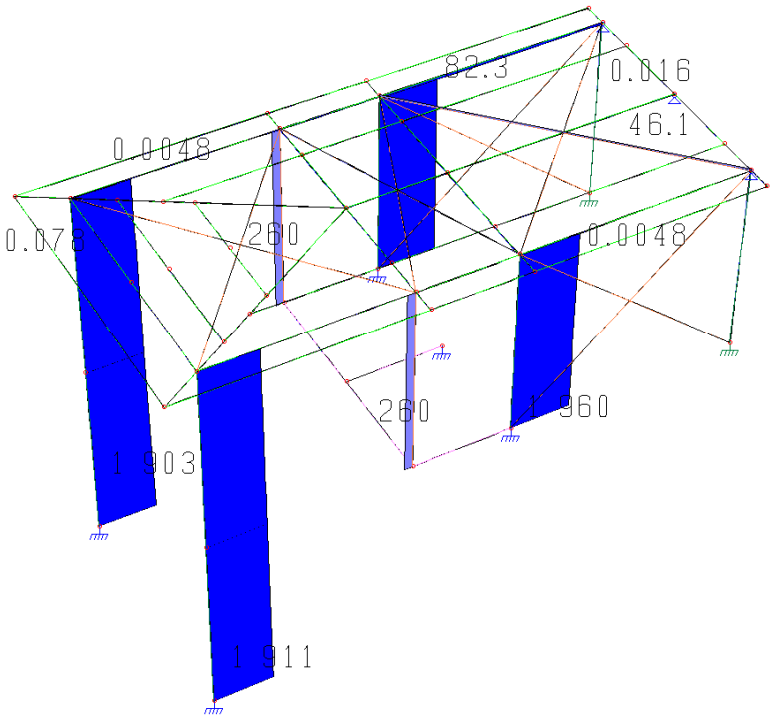
Risultati meccanismi locali di collasso

MECCANISMO DI RIBALTAMENTO	IRS_{PGA}	IRS_{TR}
a) facciata Ovest globale rispetto:		
cerniera 1 (P.T.)	1.310	3.096
cerniera 2 (P.1)	1.357	3.476
b) facciata Nord parziale rispetto alla cerniera:		
cerniera 1 (P.T.)	1.357	3.476
c) facciata Est parziale rispetto alla cerniera:		
cerniera 1 (P.T.)	1.357	3.476
d) facciata Sud parziale rispetto alla cerniera:		
cerniera 1 (P.T.)	**1.214**	**2.237**
cerniera 2 (P.1)	1.357	3.476
e) facciata Sud parziale rispetto alla cerniera:		
cerniera 1 (P.T.)	1.357	3.476
f) Cantonale Ovest		
cerniera 1 (P.1.)	1.357	3.476

Inviluppo combinazioni statiche – Indici Resistenza IR



Sollecitazioni sisma 100% x^+ - 30% y^+ – sforzo assiale N [daN]



ANNEX 19

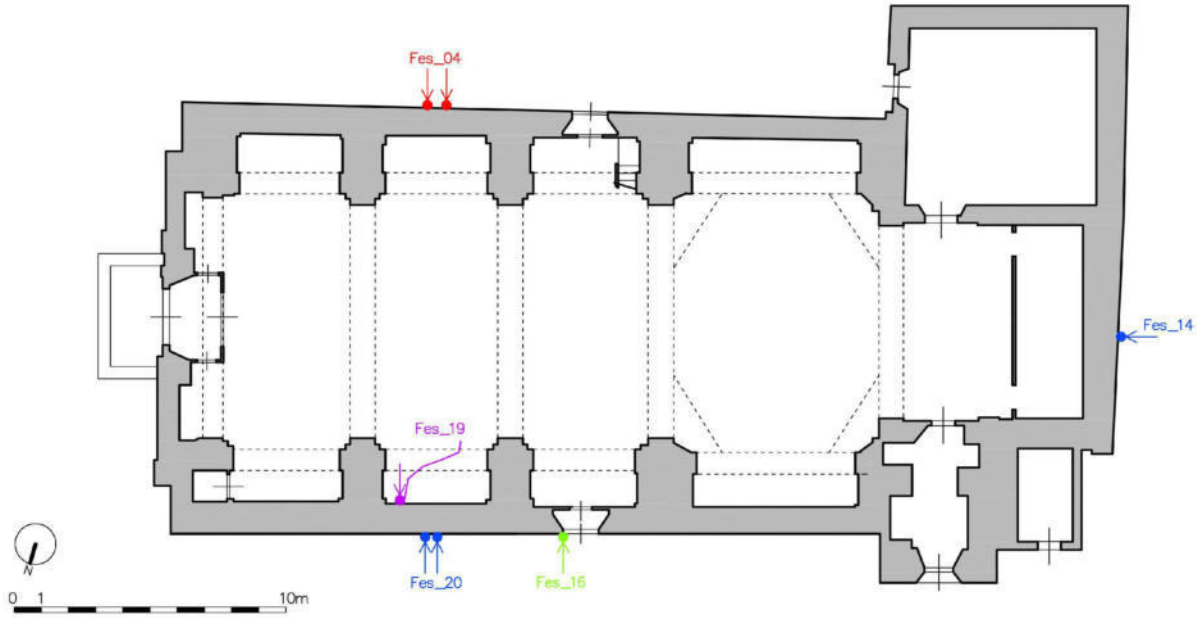
CASE STUDIES N. 7: MONITORING - SAFETY FOR STRUCTURAL HAZARD
S. Maria Church at Lovero (Sondrio)

REPORT ISPEZIONE STRUTTURALE				
Denominazione	Località	Data ispezione	**SCHEDA 1**	Pag
Chiesa di S.Maria delle Grazie	Lovero (SO)	11/05/2015	**ANAGRAFICA**	4

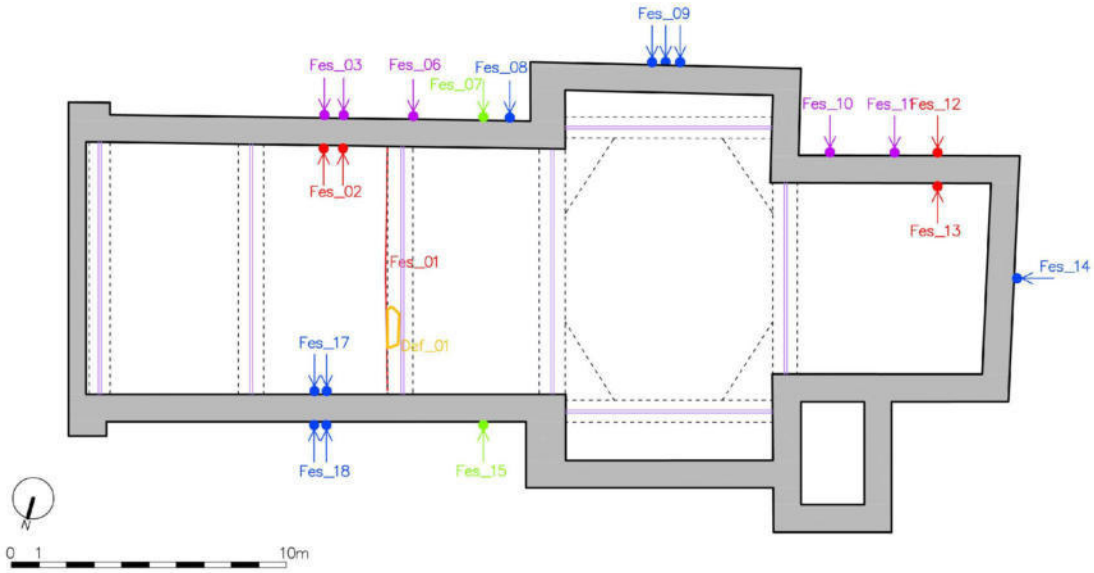
RAPPRESENTAZIONE GRAFICA E FOTOGRAFICA

REPORT ISPEZIONE STRUTTURALE				
Denominazione	Località	Data ispezione	**SCHEDA 3.3**	Pag
Chiesa di S.Maria delle Grazie	Lovero (SO)	11/05/2015	**RAPPRESENTAZIONE Q.F. E DEFORMATIVO**	7

PIANTA LIVELLO 1



PIANTA LIVELLO 2



RAPPRESENTAZIONE DEL DANNO

POSIZIONE	Prospetto sud-est ESTERNO	CODICE	FES_04	RIF. FOTO				
Rappresentazione		Descrizione						
		*Elemento*	■ muro	□ pilastro	□ solaio	□ volta	□ trave	
		Tipologia	□ fessura	■ sistema fessurativo		□ ……		
		Sviluppo	□ vert	■ subvert	□ orizz	□ suborizz	□ 45°	
		Apertura	□ submillim.	□ 1÷2mm	□ 2÷5mm	□ 5÷10mm	■ >10mm	
		Passante	□ no	■ si (corrispondenza con ……)				
		Gravità	Bassa	Media	Alta			
		Urgenza	1	2	3			

Note:

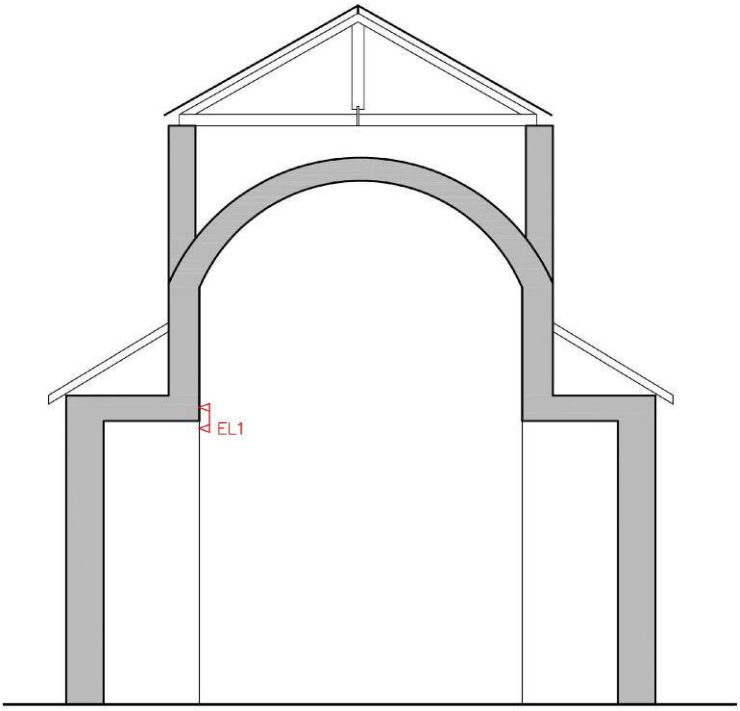
POSIZIONE	Prospetto sud-est ESTERNO	CODICE	FES_06	RIF. FOTO				
Rappresentazione		Descrizione						
		*Elemento*	■ muro	□ pilastro	□ solaio	□ volta	□ trave	
		Tipologia	■ fessura	□ sistema fessurativo		□ ……		
		Sviluppo	■ vert	□ subvert	□ orizz	□ suborizz	□ 45°	
		Apertura	□ submillim.	□ 1÷2mm	□ 2÷5mm	■ 5÷10mm	□ >10mm	
		Passante	■ no	□ si (corrispondenza con ……)				
		Gravità	Bassa	Media	Alta			
		Urgenza	1	2	3			

Note:

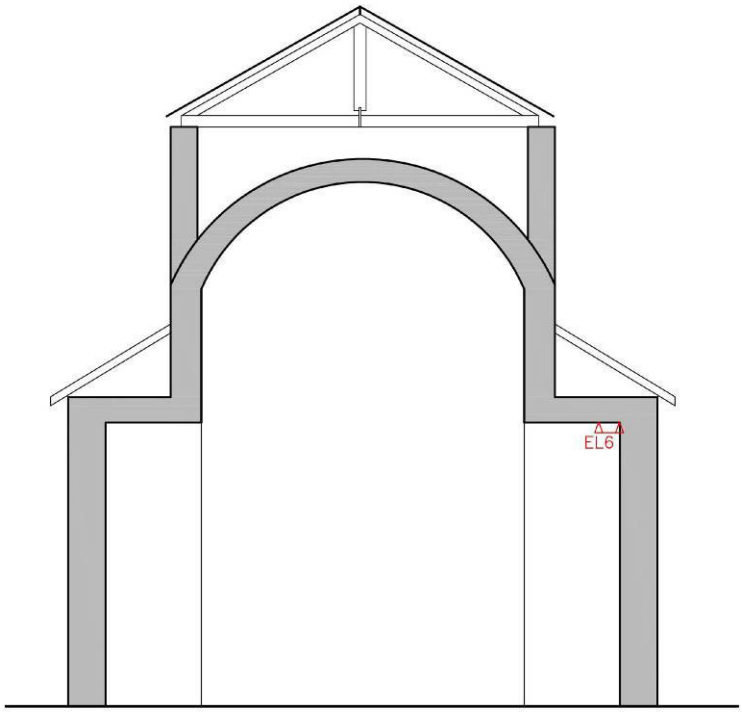
POSIZIONE	Prospetto sud-est ESTERNO	CODICE	FES_07	RIF. FOTO				
Rappresentazione		Descrizione						
		*Elemento*	■ muro	□ pilastro	□ solaio	□ volta	□ trave	
		Tipologia	□ fessura	■ sistema fessurativo		□ ……		
		Sviluppo	□ vert	■ subvert	□ orizz	□ suborizz	□ 45°	
		Apertura	■ submillim.	□ 1÷2mm	□ 2÷5mm	□ 5÷10mm	□ >10mm	
		Passante	■ no	□ si (corrispondenza con ……)				
		Gravità	Bassa	Media	Alta			
		Urgenza	1	2	3			

Note:

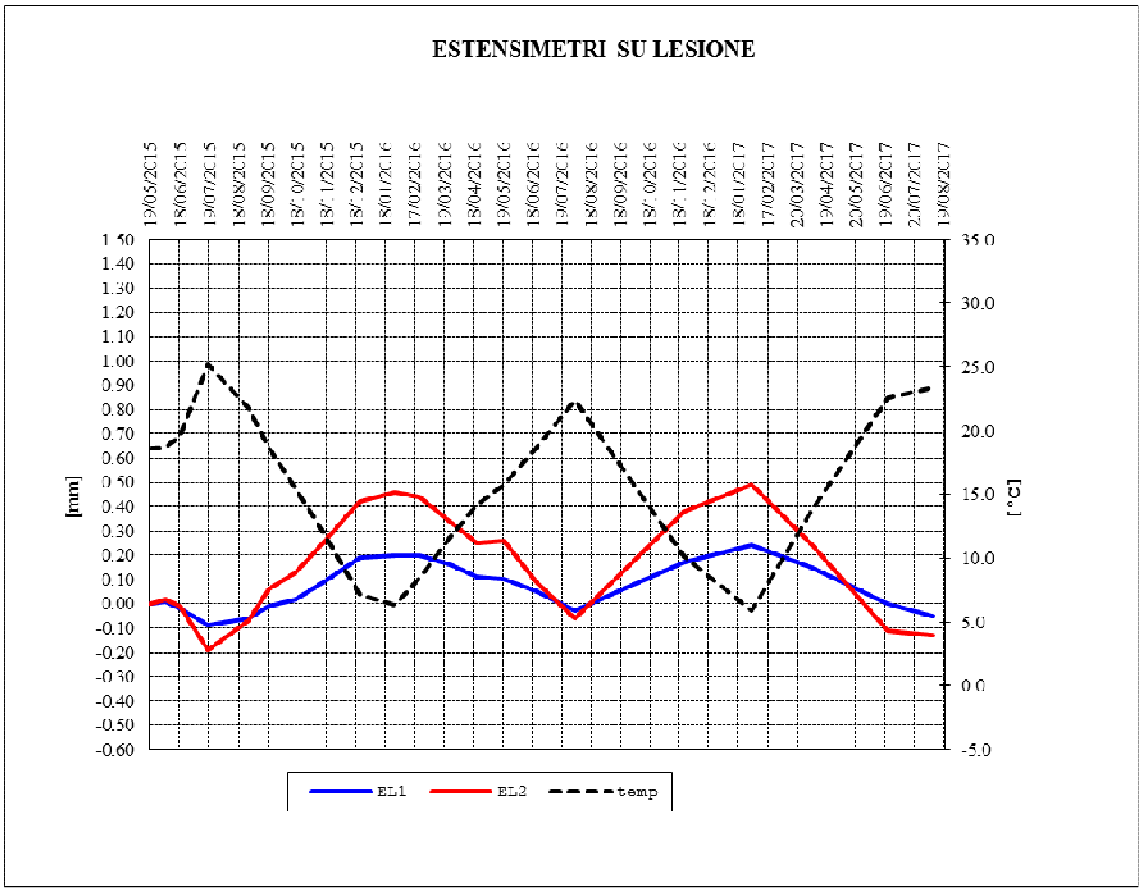
Estensimetro su lesione EL1

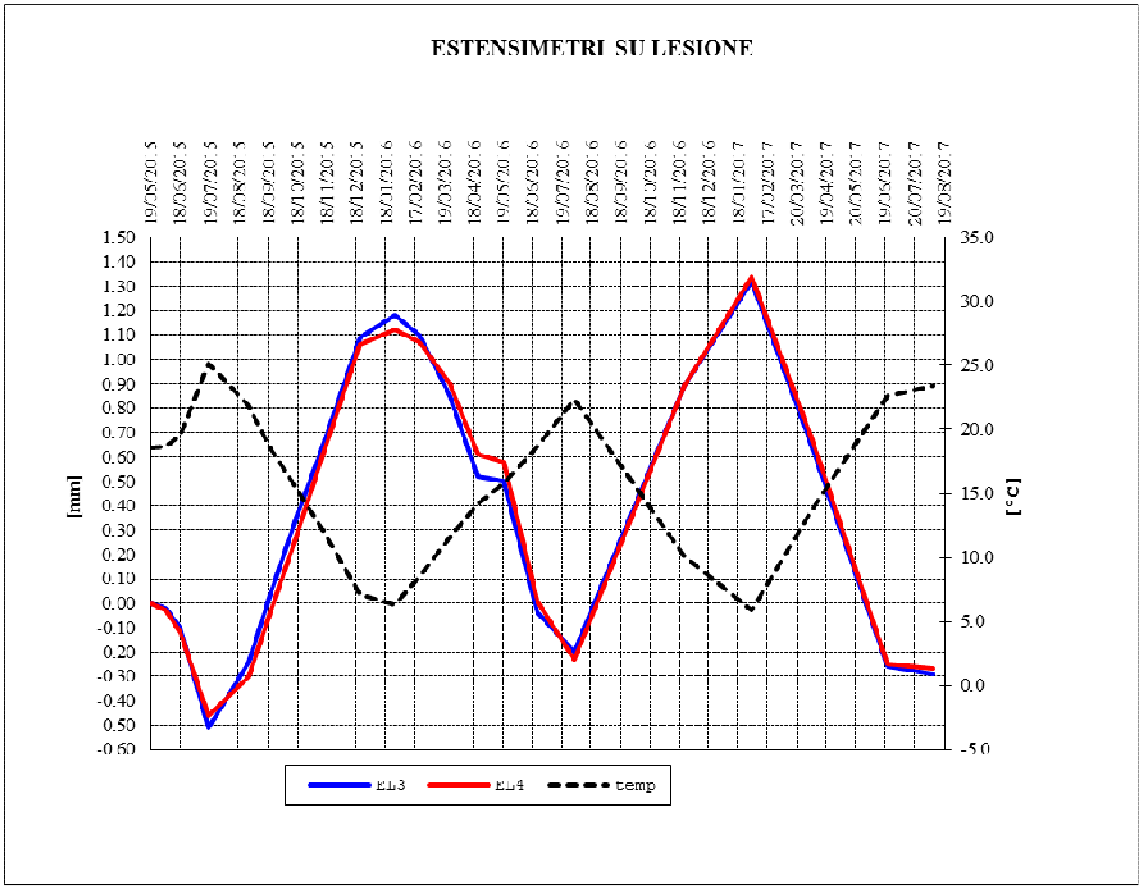


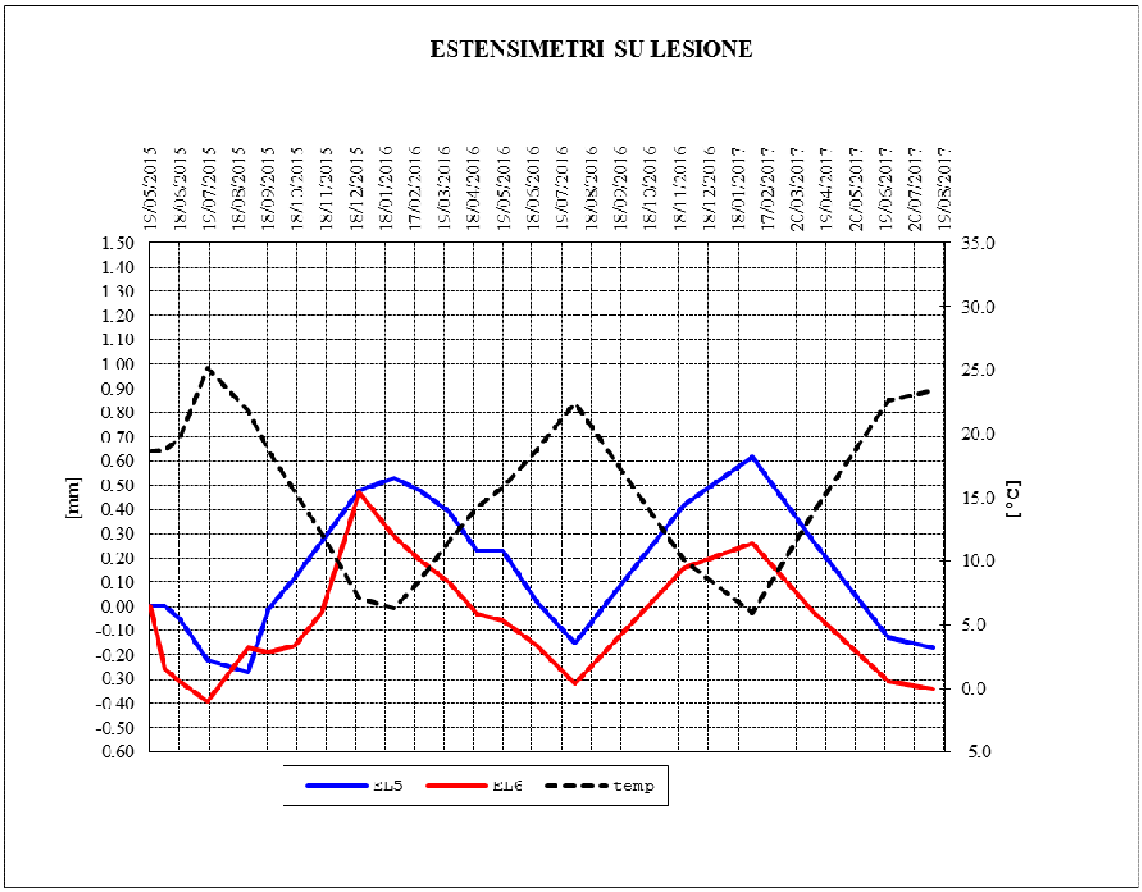
Estensimetro su lesione EL6

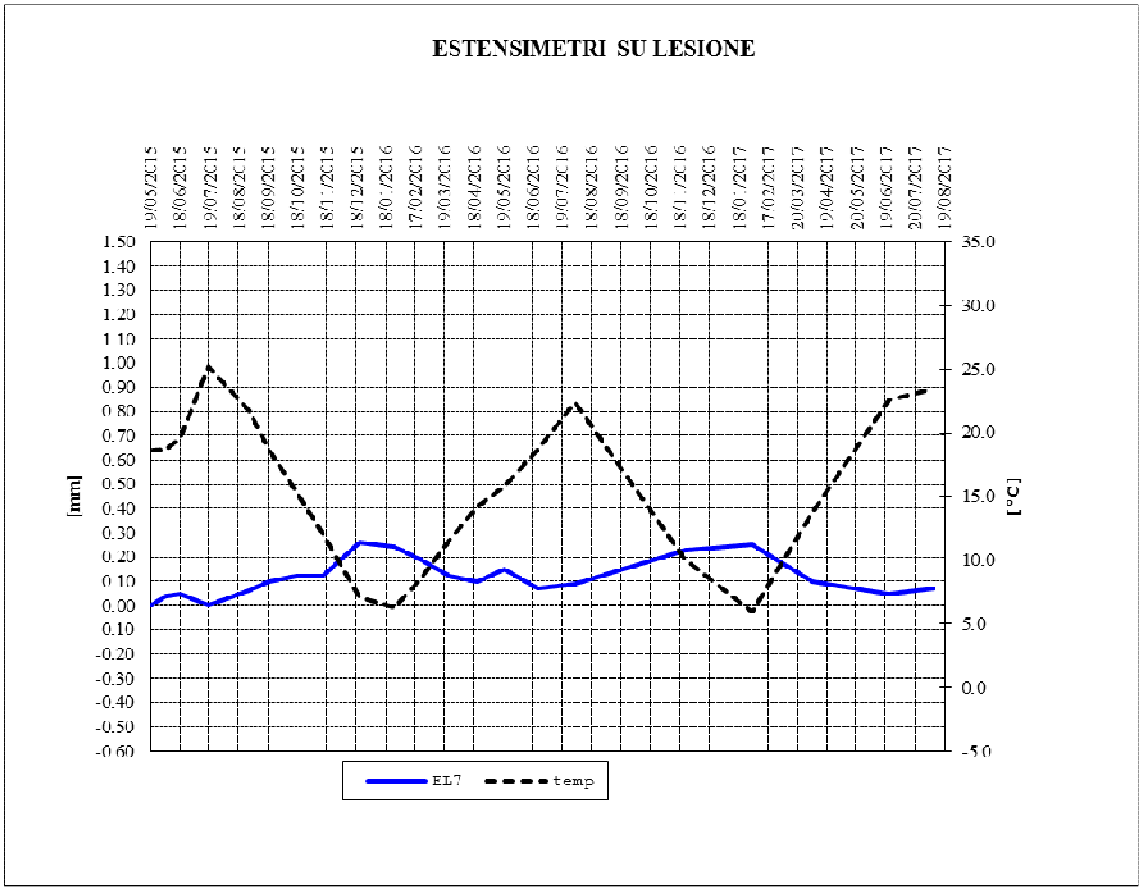


DIAGRAMMI DEI DATI ACQUISITI

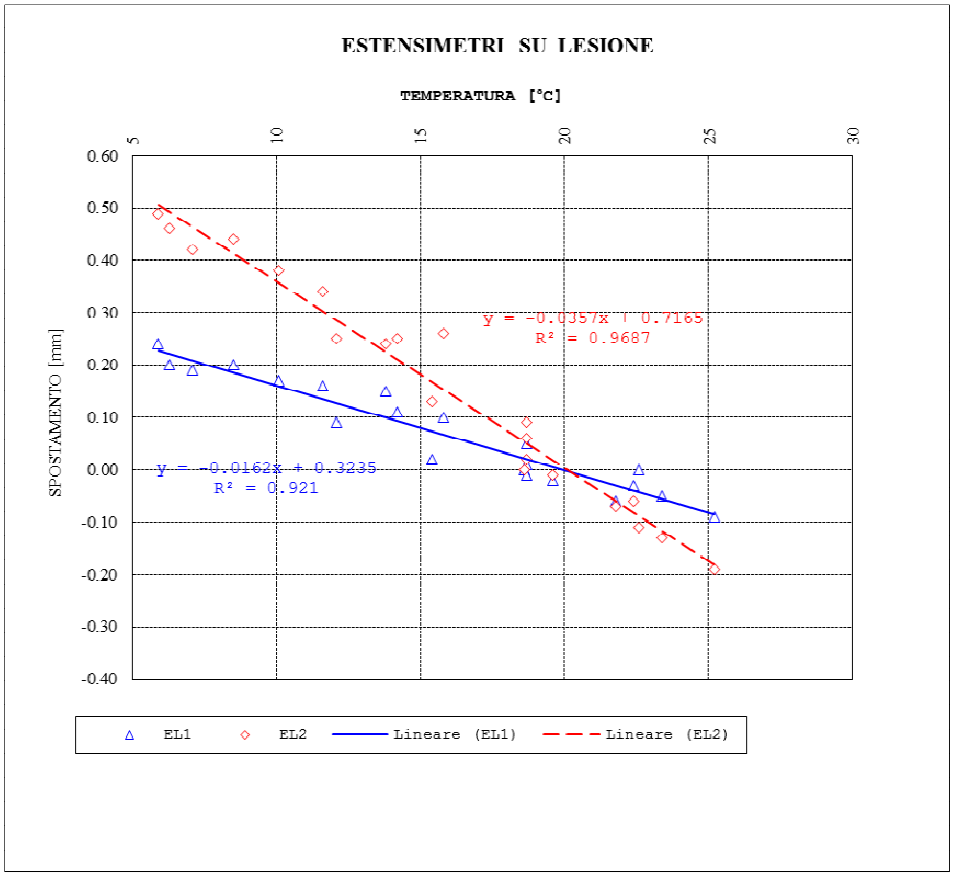


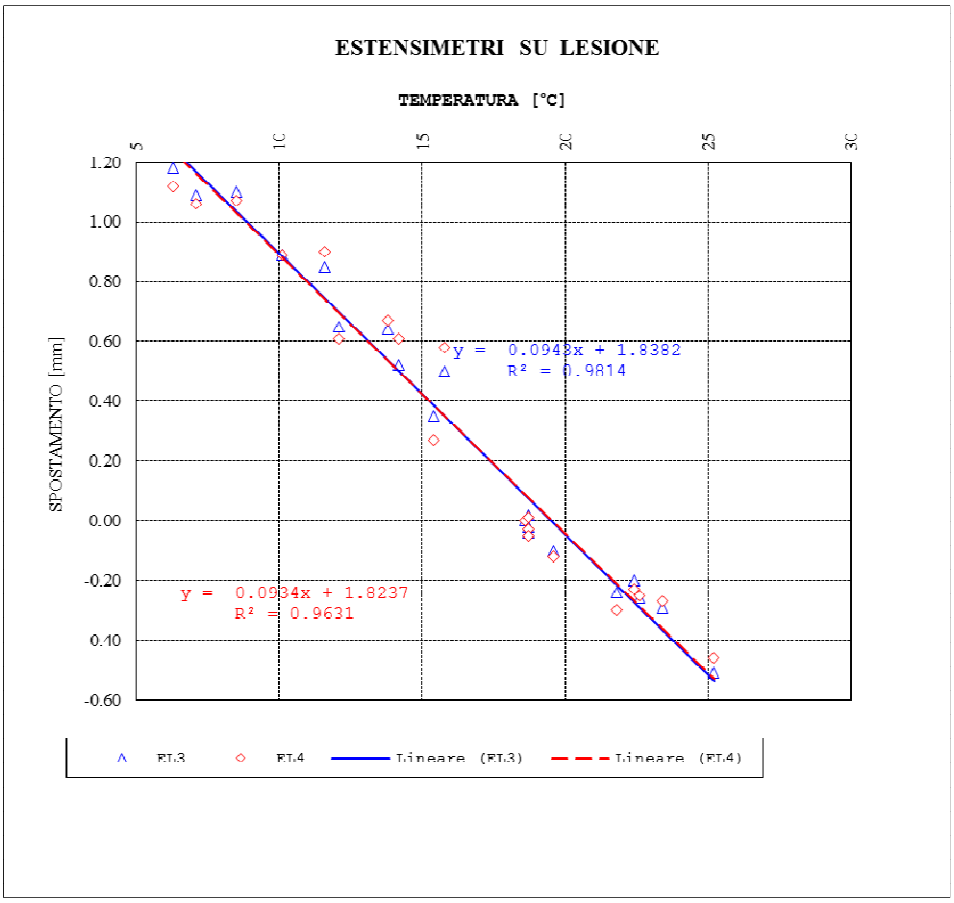


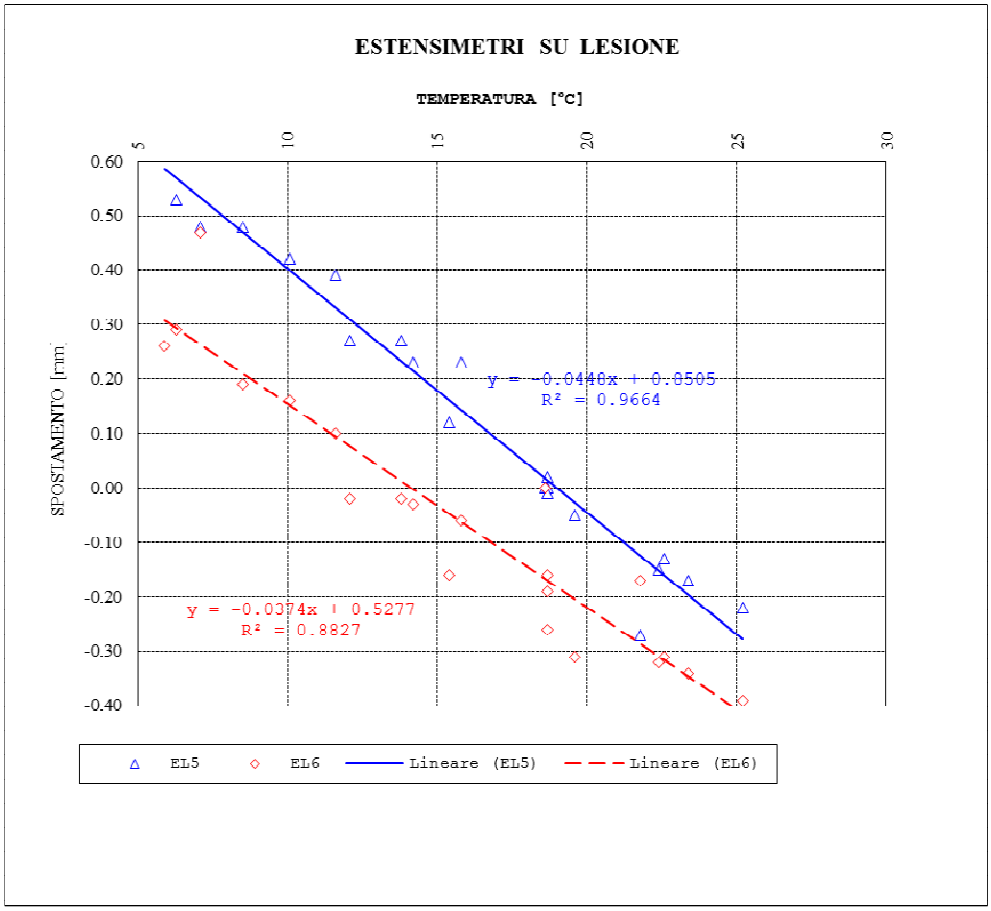

ESTENSIMETRI SU LESIONE
[mm]
[°C]
EL5
EL6
temp

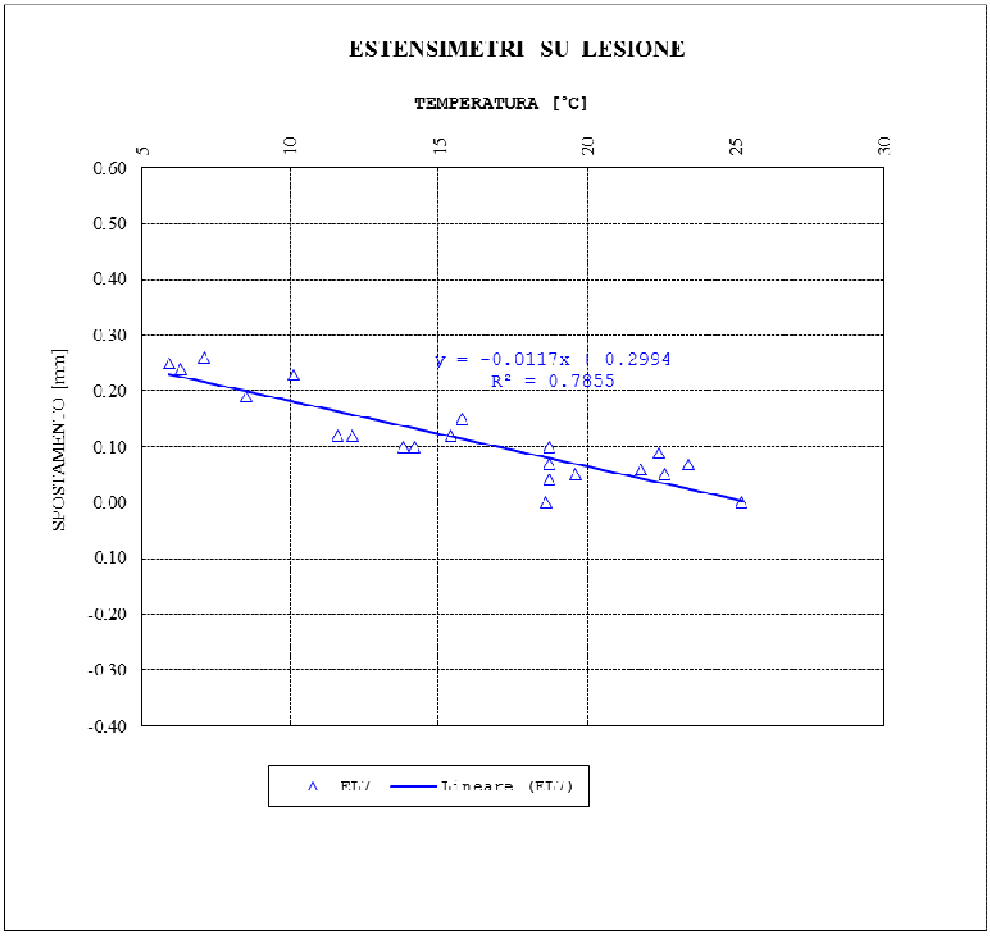

ESTENSIMETRI SU LESIONE
[mm]
[°C]
EL7
temp

DIAGRAMMI DEGLI SPOSTAMENTI RILEVATI IN FUNZIONE DELLA TEMPERATURA






ESTENSIMETRI SU LESIONE
TEMPERATURA [°C]
SPOSTAMENTO [mm]
y = -0.0446x + 0.8505
R² = 0.9664
y = -0.0374x + 0.5277
R² = 0.8827
EL5
EL6
Lineare (EL5)
Lineare (EL6)

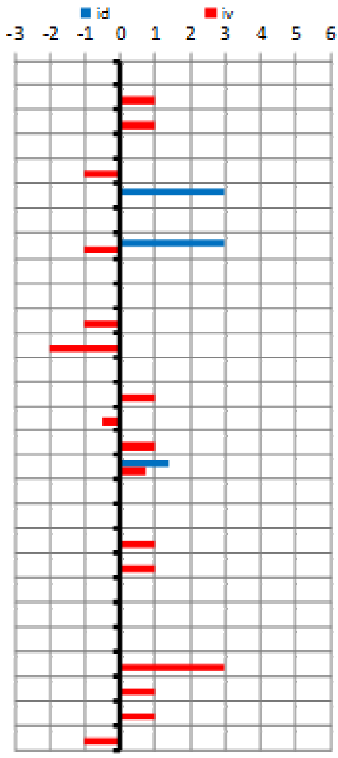

ESTENSIMETRI SU LESIONE
TEMPERATURA [°C]
SPOSTAMENTO [mm]
y = -0.0117x + 0.2994
R² = 0.7855

Valutazione della sicurezza sismica LV1

1	**SANTA MARIA - LOVERO**

i_d	Indice di Danno Totale	0,07		i_v	Indice di Vulnerabilità Totale	0,54

n°	Meccanismo di collasso	i_d	i_v
1	Ribaltamento Facciata	0,00	0,00
2	Meccanismi nella sommità della facciata	0,00	1,00
3	Meccanismi nel piano della facciata	0,00	1,00
4	Protiro – nartece	0,00	0,00
5	Risposta trasversale dell'aula	0,00	-1,00
6	Meccanismi di taglio nelle pareti laterali (risposta	3,00	0,00
7	Risposta longitudinale del colonnato nelle chiese a	0,00	0,00
8	Volte della navata centrale	3,00	-1,00
9	Volte delle navate laterali	0,00	0,00
10	Ribaltamento delle pareti di estremità nel transetto	0,00	0,00
11	Meccanismi di taglio nelle pareti del transetto	0,00	-1,00
12	Volte del transetto	0,00	-2,00
13	Archi trionfali	0,00	0,00
14	Cupola – Tamburo Tiburio	0,00	1,00
15	Lanterna	0,00	-0,50
16	Ribaltamento dell'Abside	0,00	1,00
17	Meccanismi di taglio nel Presbiterio o nell'Abside	1,40	0,70
18	Volte del Presbiterio o nell'Abside	0,00	0,00
19	Meccanismi elementi copertura – pareti laterali aula	0,00	0,00
20	Meccanismi negli elementi di copertura – transetto	0,00	1,00
21	Meccanismi elementi copertura – abside e	0,00	1,00
22	Ribaltamento delle cappelle	0,00	0,00
23	Meccanismi di taglio nelle pareti delle cappelle	0,00	0,00
24	Volte delle cappelle	0,00	0,00
25	Interazioni in prossimità di irregolarità plano-	0,00	3,00
26	Aggetti (vela, guglie, pinnacoli, statue)	0,00	1,00
27	Torre campanaria	0,00	1,00
28	Cella campanaria	0,00	-1,00



La valutazione della sicurezza sismica è stata effettuata come indicato dal DPR 09.02.2011 utilizzando il modello semplificato per la stima dell'indice di sicurezza LV1 che prevede al p.to 5.4.3 per chiese e luoghi di culto, di fare ricorso a parametri derivati dalla compilazione della scheda di rilievo del danno e della vulnerabilità di cui all'All. C1 del Decreto del Commissario delegato n.29 del 8.8.2012 (Linee guida preliminari per gli interventi di riparazione del danno e miglioramento sismico per gli edifici di culto e monumentali "EDIFICI DI CULTO - PARTE PRIMA") della Regione Molise e CNR.

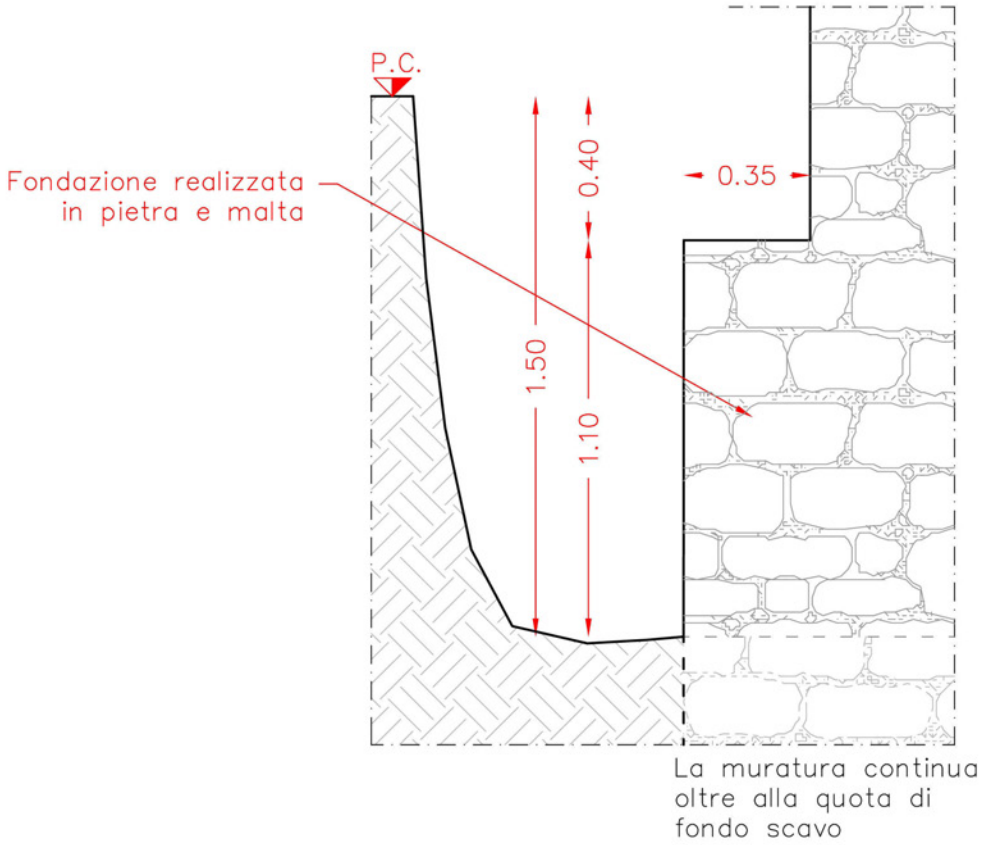
PARAMETRI SISMICI			
Latitudine	Lat	46,229230 N	
Longitudine	Lon	10,228789 E	
Vita nominale	VN	50	anni
Classe d'uso	C	2	
	CU	1	
Periodo di riferimento	VR	50	anni
fattore di confidenza	FC	1,35	
coefficiente topografico	St	1	
coefficiente stratigr.	Ss	1	
coefficiente tot.	S	1	

VALUTAZIONE SICUREZZA SISMICA	SLV		u.m.
Probabilità di superamento nella vita di riferimento:	P_{VR}	10%	
Periodo di ritorno di riferimento dell'azione sismica:	$T_{R,SLV}$	475	anni
Accelerazione orizzontale massima al sito	ag/g	0,03	g
Valore massimo del fattore di amplificazione dello spettro in accelerazione orizzontale:	F0	2,51	
Periodo di inizio del tratto a velocità costante dello spettro in accelerazione orizzontale:	TC	0,23	sec
Indice di vulnerabilità danno	iv	0,54	
Accelerazione al suolo che porta al raggiungimento dello stato limite di riferimento	a_{SLV}	0,153	g
Periodo di ritorno dell'azione sismica che porta al raggiungimento dello stato limite di riferimento	T_{SLV}	2457	anni
Indice di sicurezza sismica	$I_{S,SLV}$	5,18	
Fattore di accelerazione	$f_{a,SLV}$	2,230	
Vita Nominale	VN	258,9	anni

SONDAGGIO ESPLORATIVO S1

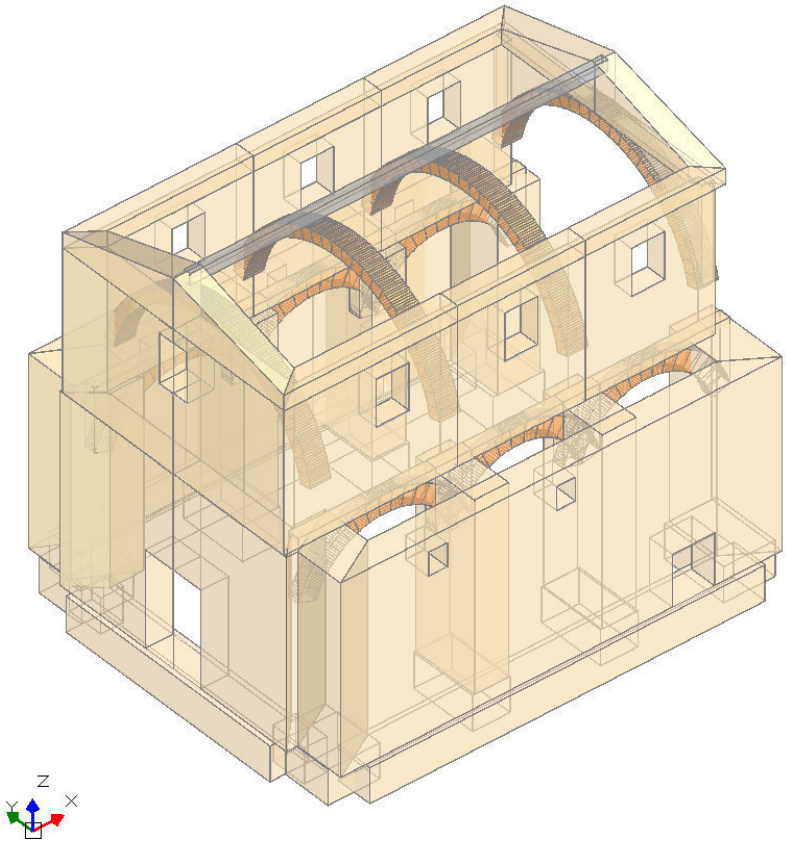
DOCUMENTAZIONE FOTOGRAFICA

SEZIONE DI RILIEVO

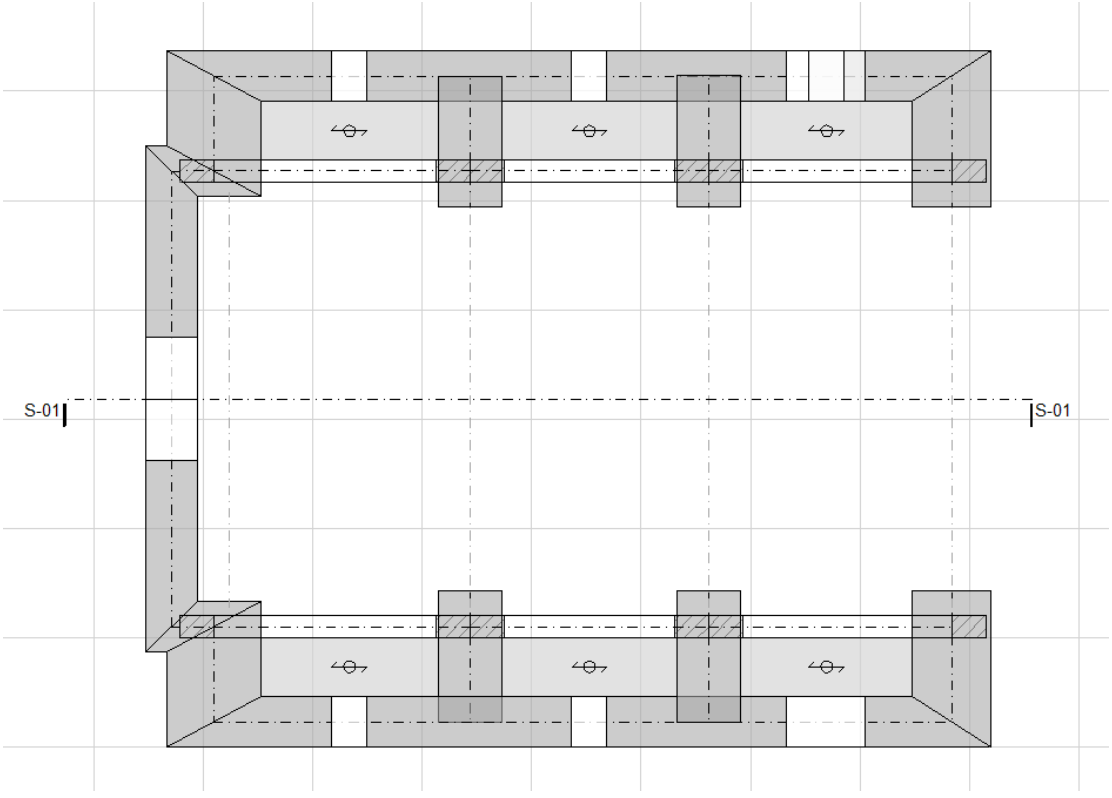


MODELLO STRUTTURALE

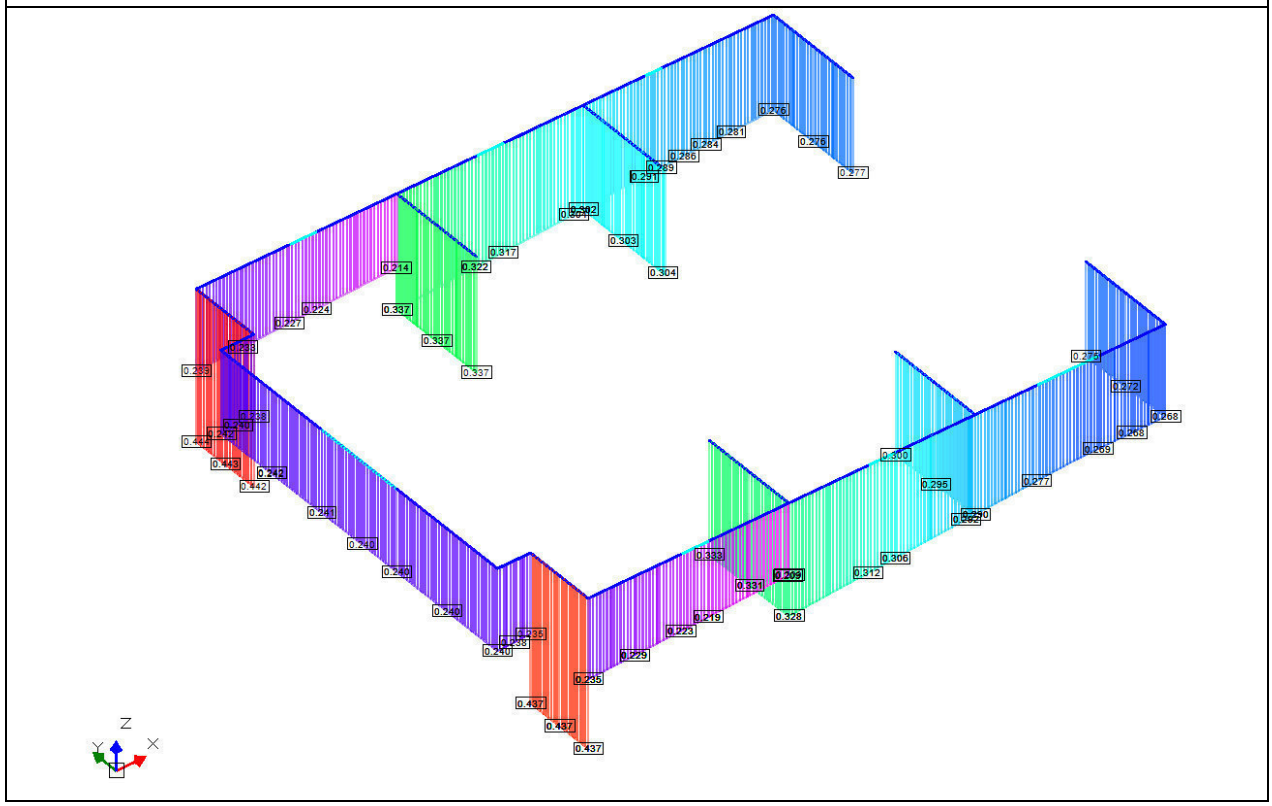
Creazione modello strutturale - Modello architettonico di partenza - Vista da Sud-Ovest



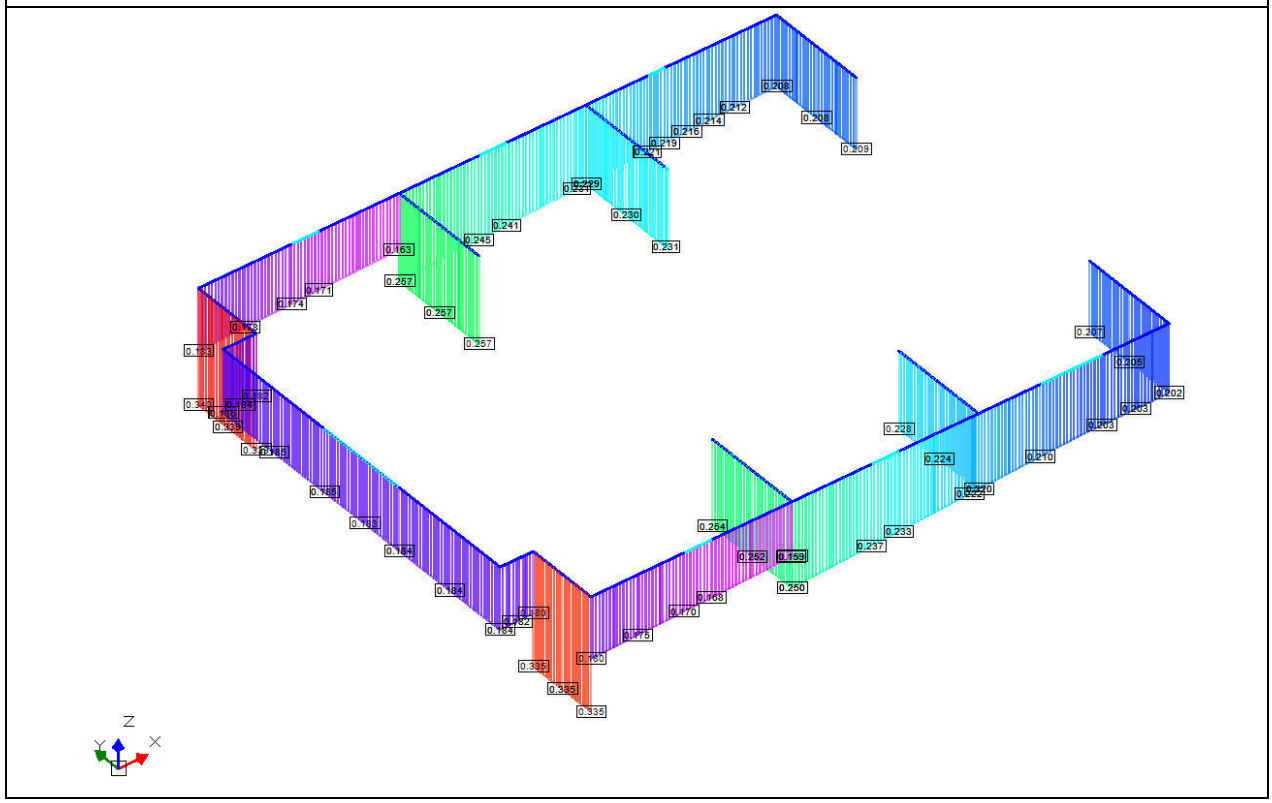
Creazione modello strutturale - Modello architettonico di partenza - Pianta



Pressioni al suolo - *Combinazione di carico:* SLU cc 37 neve fond

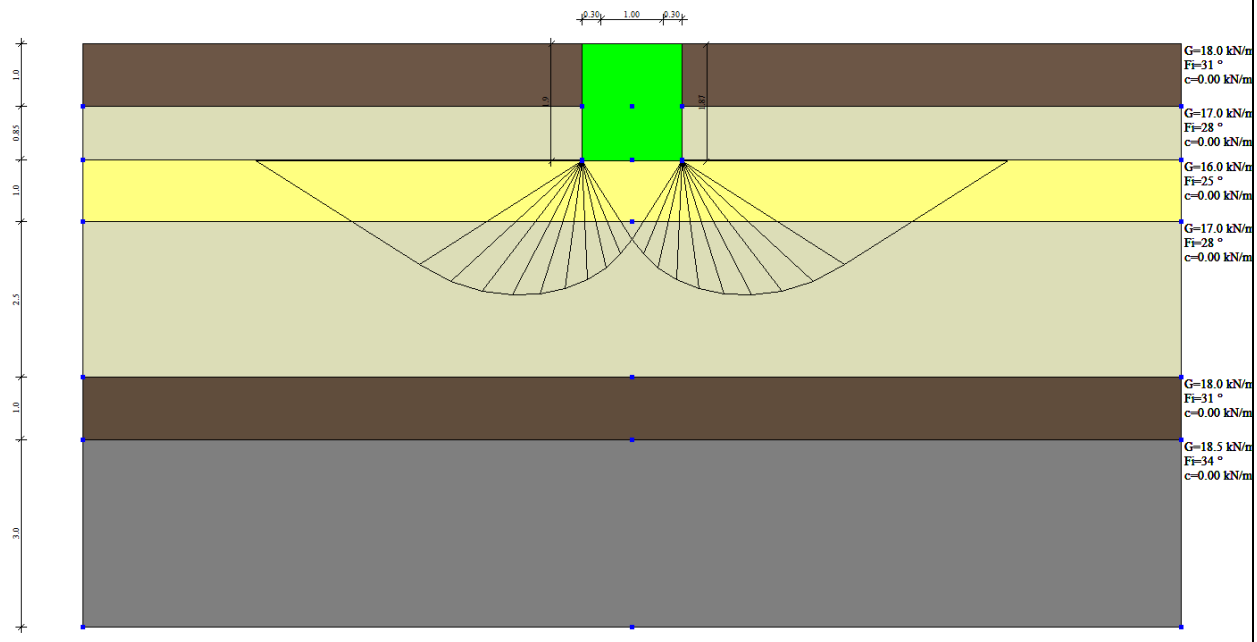


Pressioni al suolo - *Combinazione di carico:* SLE cc 37 neve fond

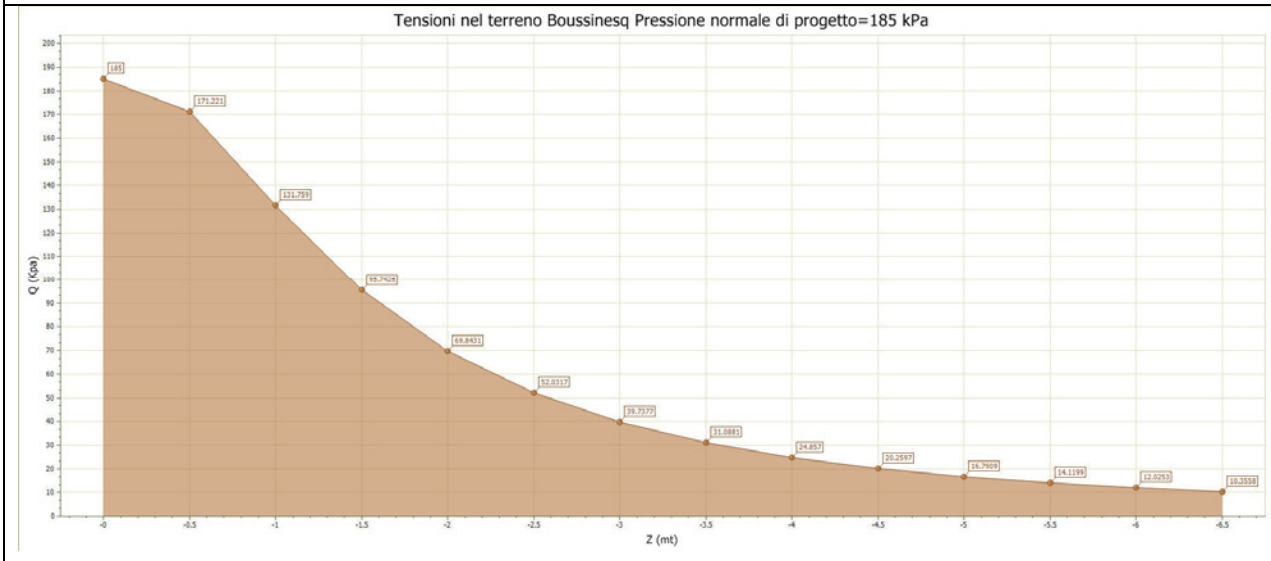


Facciata principale

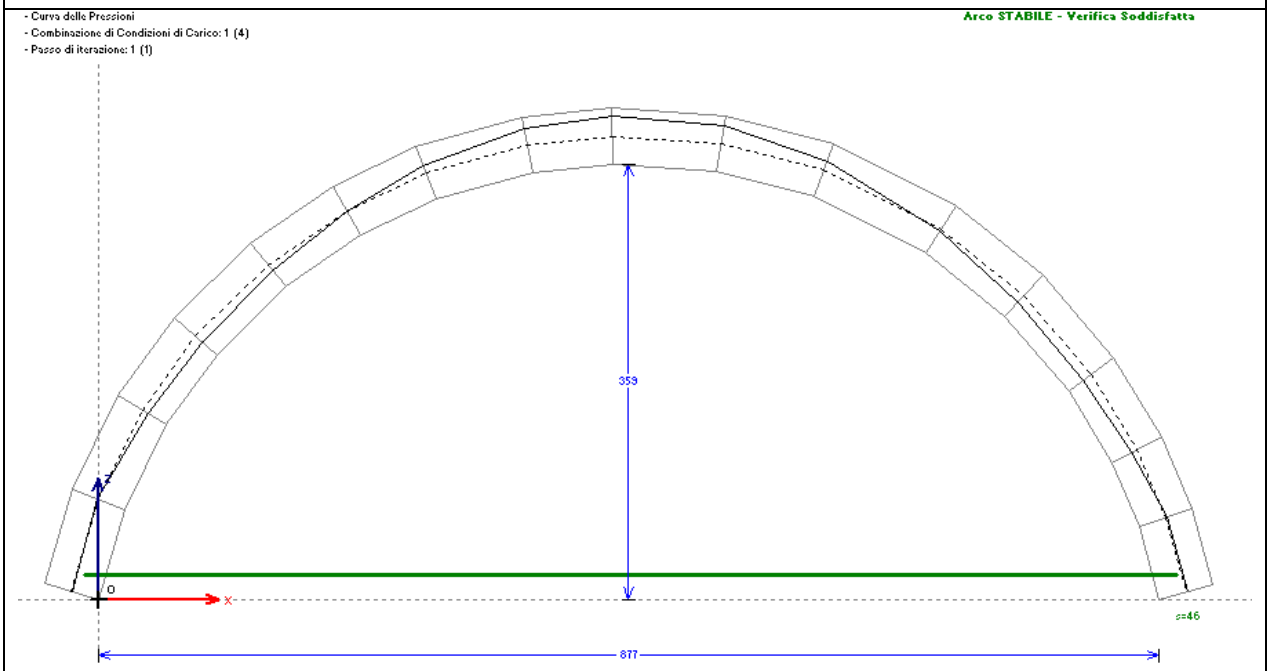
Verifica delle fondazioni – Stratigrafia fondazione Tipo 1



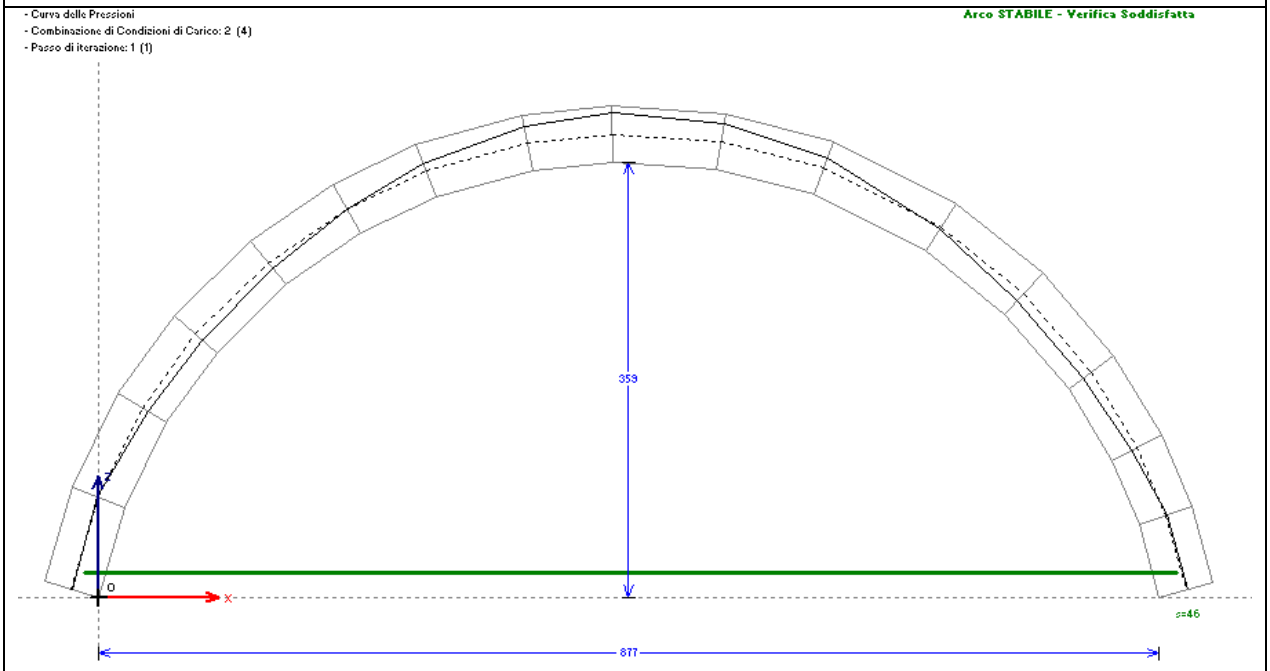
Andamento delle pressioni con la profondità – CC 37 SLE



Arco – Curva delle pressioni c.c. 1 p.p+perm



Arco – Curva delle pressioni c.c. 2 p.p.+perm+ 0,5 kN/m2 uniforme



changes

Changes in Cultural Heritage Activities: New Goals and Benefits for Economy and Society

Uploaded in December 2017.