

Regione Piemonte - Bando Scienze umane e sociali

Title

Preservation, Safeguard and Valorisation of Masonry Decorations in the Architectural Historical Heritage of Piedmont

RESPONSIBLE

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GENERAL INFORMATION

ID: 98

TITLE: Preservation, Safeguard and Valorisation of Masonry Decorations in the Architectural Historical Heritage of Piedmont

ACRONYM: RE-FRESCOS

SECTOR: Valorizzazione e Tutela del Patrimonio Artistico e Culturale

OTHER SECTORS: Scienze Politiche e Sociali, Scienze Storiche, Filosofiche, Pedagogiche e Psicologiche, Scienze dell'Antichità, Filologico-Letterarie e Storico-Artistiche,

ABSTRACT: Public awareness of the need to preserve, protect and enhance the historic heritage in question, on account of its intrinsic cultural value and its relevance to environmental concerns, is a well-established fact.

While the devastating, irreversible damage wrought by inappropriate intervention methods are right under our eyes, the experience acquired in over a quarter of a century of strengthening and restoration works has led to the following conclusions:

(a) Repair and restoration interventions must be conducted on the basis of careful investigations into the composition of the materials, construction history, deterioration mechanisms.

(b) The investigation must focus on the relationships and interactions between the decorative apparatus and the supporting masonry, the microclimate and the soil in direct contact with the structure.

(c) In Piedmont, as anywhere, it is possible to identify a multiplicity of local practices in terms of masonry construction, finishing and decoration methods that are able to make use of local materials and resources.

(d) Each local technique gives rise to special problems of compatibility with some of the integration and bonding systems to be adopted.

(e) In designing rehabilitation and restoration works it is necessary to resort to systems that have been specifically tested for compatibility, durability, and, possibly, reversibility.

The co-proponent laboratories of the Politecnico di Torino and the National Research Institute of Metrology (INRiM) are willing to fine-tune integrated investigation, using non invasive methods, specially designed for dealing with the highly diversified historic heritage of Piedmont, with the aim to remedy current shortcomings in the identification of

effective and compatible restoration and maintenance techniques.

The physical-chemical decay and the damage evolution of materials constituting the decorated surfaces and the support can be caused by infiltrations of water, thermo-elastic stresses, or seismic and environmental vibrations. The physical-chemical degradation will be dealt with Materials Science and Chemical Engineering techniques.

The stability of the decorated surfaces will be investigated by innovative Acoustic Emission (AE) and ultrasonic methods already experimentally tested in the field of artistic and monumental Italian cultural heritage. The ultrasonic investigation techniques allow to assess separations, defects and damage phenomena that can regard the decorated surfaces and the masonry supports. Innovative acoustic methods will allow to distinguish a well preserved artwork in comparison to a damaged one.

The stability and the dynamic behaviour, induced also by seismic and environmental vibrations, will be monitored by the AE technique using wireless transmission systems to control continuously and simultaneously decorated surfaces, situated in different sites of Piedmont.

The data collected during the experimental tests conducted in situ will be interpreted with Fracture Mechanics models and methodologies.

Subsequently, the design of the most appropriate technique turns out to be crucial as well as the selection of the most suitable repair products in terms of durability and compatibility. Moreover, innovative lab methodology will be developed for material prequalification based on uni-axial static and tri-axial fatigue tests.

The research team involved in this Project has found in the Sacri Monti of Piedmont (belonging to the UNESCO World Heritage List since 2003) different case-histories where the proposed analysis assume a fundamental role for preservation and maintenance of these monuments.

The research activity will be developed by different subjects: The Politecnico di Torino and the National Research Institute of Metrology (INRiM), and involving the Special Natural Reserve of the Sacro Monte di Varallo as co-proponent. The results will be largely disseminated by Territorial Authorities (FAI, Local Tourist Agencies, etc.).

DURATION (months): 36

TECHNICAL SCIENTIFIC OBJECTIVES: Today the artistic heritage of mural paintings and decorated surfaces in Piedmont requires the use of new technologies and highly sophisticated monitoring methodologies able to provide a precise mapping of damage. This diagnostic phase has to necessarily be accompanied by interventions of preservation based on a consolidated know-how in the experimental pre-qualification of materials used in restoration.

The physical-chemical decay of historical artworks after consolidation interventions will be simulated in the lab on specimens having similar physical-chemical properties. Their properties will be studied after ageing tests, by means of analytical techniques and instruments such as: Scanning Electron Microscopy (SEM), X-ray diffraction, thermal analyses, such as Thermogravimetric Analysis and Differential Scanning Calorimetry (TGA-DSC), Mercury Porosimetry Intrusion (MPI), determination of salts content by means of standard colorimetric kits, portable colorimetry, portable conductimetry and Fourier Transform Infrared (FTIR) spectroscopy. Moreover, low cost and low impact qualitative tests for fast quality evaluation of the protective superficial layer, if present, will be set-up.

As far as structural stability is concerned, traditional diagnostic techniques used in damage analysis often turn out to be too invasive and not suitable to be applied to decorated surfaces and of mural paintings. On the contrary, some of the most recent methodologies, based on the principles of Acoustics, guarantee a totally non-invasive and precise diagnostic in damage localization.

The Research Team involved in this Project aims to create an integrated and interdisciplinary network of scientific laboratories on the Piedmont territory, highly qualified

at the international level and able to employ the most recent and innovative acoustic-based diagnostic tools and methodologies, already experimentally tested in the field of artistic and monumental Italian cultural heritage.

The experimental AE instruments used at the moment by the Research Team will be supplied with wireless sensors and with centralised stations for the telematic collection and treatment of recorded data. It follows that structural elements and/or entire manufactures, even if situated in different places, will be able to be monitored in real time and simultaneously. In this way an innovative diagnostic methodology will be applied to assess the mural painting patrimony of Piedmont.

At the same time, a scientific research activity will be developed to pre-qualify the most appropriate consolidating materials, according to specific standards (UNI, Normal). The main goal is indeed to employ the large scientific experience matured by the different proponent subjects to cover all the phases for a careful maintenance of the artistic heritage of Piedmont.

The innovative acoustic techniques applied by the Research Team will be able to give a detailed map of defects and separations among the various layers that are present in the system constituted by the decorated surface and its support. At the same time a numerical analysis based on Fracture Mechanics will allow to study and understand the stability and the evolution of the damage in progress.

The wide experience obtained by the Research Team, during several prequalification tests on consolidating materials, will allow to study and choose the most durable and appropriate material for the consolidation of each decorated surface.

The whole scientific know-how of the different laboratories constituting the Research Team could be adopted by the Superintendence in the restoring interventions and in the preservation of mural painting heritage in Piedmont.

The research team has identified in the Sacri Monti of Piedmont (belonging to the UNESCO World Heritage List since 2003) different case-histories where the diagnosis of the damaged decorated surfaces assumes a fundamental role for the preservation and maintenance of these monuments.

STATE OF THE ART: Several cases of incorrect restoration interventions can be found in every day life and must be ascribed to the use of inadequate products, having too much different chemical-physical properties with respect to the original ones. Additional inefficiency causes can be found in the presence of chemical interactions between the substrate and the new materials employed.

The starting point for a correct approach in the preservation of decorated artworks requires to collect a large amount of historical and scientific information in order to provide a full understanding of the problem. Only in this way, it will be possible to plan the required operations to preserve the artwork. The scientific examination may often be represented by the whole data coming from different analyses. This approach is the base for a real collaboration among historical, scientific and technical experts to draw correct interventions.

Nowadays, the investigation techniques used to evaluate the preservation level of artworks are UV visible photography, infrared reflectography (IRR) and X-ray radiography (XR).

These techniques are only able to provide an instantaneous image of the degradation level, but they cannot provide information on the damage evolution of supports and of external decorated surfaces.

In particular, the damage of the supports is often neglected in restoration works. On the other hand, the present analysis is crucial to preserve the artwork stability. The integration among different techniques proposed by the Research Team means to be a suitable and innovative answer to each of the problems described above. The different techniques proposed for the damage investigation of decorated masonries, may be able to give information on the damage evolution of the decorated surfaces and of the bearing

supports. The collected data will be interpreted by experts in order to choose the best solution for the preservation and for the maintenance of the decorated artworks.

POTENTIAL IMPACT: The research team will combine and integrate different methodologies in order to correctly operate on the works of art of the Piedmont historical heritage.

In this framework, a first social and economical impact will regard those works of art which have been almost ignored until now: they will be able to go back to their original splendour and become cultural and touristic poles, as well as a good chance for territorial economy. Indeed, in the last few years Turin and the Piedmont's territory have been slowly leaving back the industrial identity to acquire a new connotation, based on the presence of artistic and touristic centres of exceptional interest. On this base, the activities of the research team will be of primary relevance in the valorisation and preservation of the historical and artistic heritage of Piedmont.

In a social-economical context, a second impact will regard the chance to optimise restoration costs through a careful diagnosis. The innovative techniques here proposed will indeed lead to the individuation of the true degradation causes. As a consequence, all restoring interventions will be specifically thought for any specific problem with a consequent costs saving.

One of the main benefits will also be that of acting on the large amount of artworks in our regional territory, returning artistic goods of unquestionable value (which are now ignored because of their degradation state) to their municipalities, districts and communities.

Also, the results of the highly qualified technical activity will be a great contribution in the valorisation of the territory and will be able to satisfy the technical demands of the restoring subjects. The same results could be used by the Public Authorities for a better qualification of their activities and for an economic return on the territory.

The outcome of the interdisciplinary activities will be presented in scientific publications and in intervention guidelines, both at a national and international level. Thus, the potentiality of the proposed techniques will be suitably spread and the visibility of the artistic heritage of Piedmont will be promoted as well.

DESCRIPTION OF THE RESOURCES: The project Proposers are the Politecnico di Torino (DISTR, DISET and DISMIC Departments) and the INRiM Institute, that will carry out high-level scientific activity and involve human and laboratory resources suitable to the development of the proposed research; the Politecnico di Torino also disposes of further important resources such as databases, libraries and advanced information and communication technologies.

Besides, the Co-proposer (the "Special Natural Reserve of the Sacro Monte di Varallo") is a relevant Public Authority in the regional area, disposing of advanced human and technological research capabilities.

Human resources

Considering the Politecnico di Torino (DISTR, DISET and DISMIC Departments), researchers of high scientific level, well-known at national and international level, are involved: 4 Full Professors, 1 Associate Professor, 7 Assistant Professors, 3 PhD. Students, 3 Laboratory Technicians.

In addition, the project also accounts for 7 research grants and 1 Phd fellowships to be assigned to young researchers.

Considering the INRiM, 1 Prime Researcher, 1 Researcher, 1 PhD. Student, 1 Laboratory Technician.

Considering the Co-proposer ("Special Natural Reserve of the Sacro Monte di Varallo"), 1 Technical Director, and 2 Laboratory Technicians.

Laboratory and equipment resources

Laboratories and equipment resources at DISTR Department of the Politecnico di Torino:

- Non destructive Testing Laboratory: Material Test System (MTS) for bending, tensile and compression tests, ultrasonic transducers and related equipment, oscilloscope, flat jacks.
- Fracture Mechanics Laboratory: Material Test System (MTS) for bending, tensile and compression tests, Acoustic Emission equipment consisting of six PZT transducers, six memory units and a synchronization central system.
- "A. Castigliano" Computational Mechanics Centre.
- Materials and Structures Laboratory.
- LADISSS (Experimental Didactic Laboratory for Structural Safety).
- LAQ-MIR (High Quality Laboratory).

Laboratories and equipment resources at DISET Department of the Politecnico di Torino:

- Thermostatic and Climatic camera Angelantoni Challenge 250.
- Termographic camera Terma CAM B2 – FLIR SYSTEM
- Contact and Infrared rays thermometer Thermohygrometers.

Laboratories and equipment resources at DISMIC Department of the Politecnico di Torino:

- Scanning electron microscopy (SEM) with energy dispersive X-ray spectroscopy (EDX) (Hitachi S2300)
- X-ray diffraction (Philips PW1710).
- Devices for thermal analyses, such as thermogravimetric analysis and differential scanning calorimetry (TGA-DSC) (Netzsch STA 409).
- Mercury porosimetry intrusion (MPI) (Carlo Erba 2000).

Laboratories and equipment resources at Thermodynamic Division Department of the National Research Institute of Metrology (INRIM), Torino:

- N.2 Microphones (1/4"), B&K 4139; N.2 Microphone pre-amplifier, B&K 2619 ;
- N.1 two-channels Microphone Power supplier, B&K 2807; N.1 Function generator (sine random generator), B&K 1027; N.1 Power amplifier, B&K 2706; N.1 Real time two-channels Frequency analyzer; N.1 Personal computer.

ORGANIZATION: The project Proposer Leader is the Department of Structural and Geotechnical Engineering (DISTR) of the Politecnico di Torino in cooperation with the other project Proposers: the Department of Building Engineering and Territorial Systems (DISET), the Department of Materials Science and Chemical Engineering (DISMIC) of the Politecnico di Torino and the Thermodynamic Division of the National Research Institute of Metrology (INRiM).

The Project Responsible is Prof. Alberto Carpinteri (DISTR), the Vice-Responsible is Prof. Pietro Giovanni Bocca (DISTR).

The Co-proposer is a relevant Public Authority of Piedmont Region involved in the preservation, safeguard and restoration of historical artistic heritage: the Special Natural Reserve of the Sacro Monte di Varallo.

Work plan:

The project is divided in 6 work packages, the WPs Leaders are full Professors and Researchers of the Politecnico di Torino and Researchers of INRiM; in each work phase, Researchers of the different Departments are involved. The WP indication is listed in the following:

- WP1) Characterization of historical surface finishing and execution techniques. Study of materials and their mixing ratios. Definition of specific interventions. WP Leader: Arch. Marco Zerbinatti (from month 1 to month 36).

- WP2) Damage Analysis of Decorated Surface Structural Support by the Acoustic Emission Technique. WP Leader Arch. Giuseppe Lacidogna (from month 1 to month 36).
- WP3) On site monitoring of mural decorative artworks using advanced ultrasonic techniques - Laboratory prequalification of injection grouts to be used in repair works. WP Leader Prof. Pietro Giovanni Bocca (months: from 2 to 36).
- WP4) Upgrading and recovery of mural painting assets in Piedmont: the problem of reliability and durability of the media. WP Leader Dr. Alessandro Schiavi (months: from 1 to 29).
- WP5) Analysis of debonding phenomena in decorated mural elements by numerical models based on Fracture Mechanics. WP Leader Eng. Marco Paggi (months: from 13 to 30).
- WP6) Dissemination and diffusion of the results. WP Leader Prof. Gianpaolo Scarzella (months: from 12 to 36).

The Co-proposer will collaborate in the work-packages, respecting the specific roles of their Researchers involved.

Management of the project. The Responsible and the Viceresponsible will directly answer for the Project activities to the Regione Piemonte. In order to monitor the research activities and resource management, they will meet together with the WP Leaders at the end of the first and the second year and in the middle of the third year. The Responsible is accountable for handling all communications with the Regione Piemonte, ensuring that all project results are submitted on time, creating necessary conditions for successful collaboration among Partners.

Information flow. With respect to technical issues, information flow will be achieved through the organisation of internal meetings at Politecnico di Torino among the Researchers and the Responsibles. With respect to the managerial, administrative and financial issues, communication and information flow will be achieved through the above-mentioned meetings and through the distribution of intermediate research reports.

Management Rules for Project Quality Assurance. The aim of Quality Assurance is to provide the research project with methods, standards and procedures, to prepare and to implement controls in order to take a permanent and critical view of the project, as well as to measure the progress and quality of results.

DISSEMINATION: Progressive development in the research will be periodically published on a dedicated web site, as well as on congress proceedings and on specific scientific journals, of national or international relevance.

The outcome of the interdisciplinary work will lead to the definition of procedures for the investigation and intervention with a practical spin-off. For this reason, a book, focused on the scientific results of the research carried out by all the involved subjects, will be edited and spread to the Superintendences and to the public and private offices of the Piedmont Region implicated in preservation and valorisation of the mural painting heritage, as well as to the self employed people and restorer who will request it.

Also, at the end of the activity a national conference will be held at the Politecnico di Torino to illustrate and discuss all the results achieved during the research program.

The realisation of prototypes based on wireless networks and on novel ultrasonic investigation procedures for decorated surfaces and their bearing walls will allow to divulgate the new technologies, through technical meetings for experts in restoration and conservation.

Finally, investigating the relation between the AE activity and the regional seismicity during the monitoring period, the Acoustic Emission technique will be used as a warning

for the preservation of the monitored artworks from the seismic risk. In this connection, the AE monitoring sensor networks installed during the project activity in different monitored sites will be directly connected to the “Centro Funzionale per la Previsione ed il Monitoraggio Ambientale del Piemonte”.

DIFFUSION OF THE RESULTS: Concerning the diffusion of the results of the research, the project intends to produce:

- a dedicated web site where the project will be described in detail; the development of the research will be presented and the most important results will be highlighted;
- scientific and technical papers on national and international journals and conference proceedings about the progress in the research;
- a special book, containing the final results, that will be distributed to universities, superintendences and Public Authorities;
- a national conference at the end of the project.

ISSUES ETHICS: The project “Preservation, Safeguard and Valorisation of Masonry Decorations in the Architectural Historical Heritage of Piedmont” does not involve ethically sensitive issues. It addresses no action regarding human cloning, modification of the genetic heritage of human beings, and human embryos.

The project respects the current national Italian legislation and regulations, as well as the legislation of the Regione Piemonte, where the research will be carried out, of the EU and all the International Conventions and Declarations.

The research is not addressed to topics regarding either clinical practice or proprietary medicinal products, biotechnological inventions, genetically modified organisms or processing of personal data.

The partners involved in this project, Politecnico di Torino (DISTR, DISET and DISMIC Departments), National Research Institute of Metrology (Thermodynamic Division) and the Co-proposer “Special Natural Reserve of the Sacro Monte di Varallo” confirm that the proposed research does not involve:

- Research activity aimed at human cloning for reproductive purposes;
- Research activity intended to modify the genetic heritage of human beings which could make such changes heritable;
- Research activity intended to create human embryos solely for the purpose of research or for the purpose of stem cell procurement, including by means of somatic cell nuclear transfer;
- Research involving the use of human embryos or embryonic stem cells.

Considering the gender issues, the researchers involved in the project, titled “Preservation, Safeguard and Valorisation of Masonry Decorations in the Architectural Historical Heritage of Piedmont”, are at the excellence scientific level, without gender discrimination. The respect of the “equal opportunities” principle has been taken into account in defining the responsibility of the roles.

In the following list, the female participants to the project are reported :

- Paola Antonaci, Politecnico di Torino, Assistant Professor , WP3 and WP6 participant.
- Caterina Bruno, Politecnico di Torino, PhD. Student, WP3 and WP6 participant.
- Alice Destefanis, Politecnico di Torino, PhD. Student, WP2 and WP6 participant.
- Erica Cadamuro, Politecnico di Torino, PhD. Student, WP5 and WP6 participant.
- Paola Palmero, Politecnico di Torino, Assistant Professor, WP1 and WP6 participant.
- Enrica Barzotto, Politecnico di Torino, Technician, WP1 and WP6 participant.
- Elena de Filippis, “Special Natural Reserve of the Sacro Monte di Varallo”, Technical Director, WP1 and WP6 participant.
- Elena Bellazzi, “Special Natural Reserve of the Sacro Monte di Varallo”, Technician, WP1 and WP6 participant.
- Giuliana Benedetto, INRiM, Prime Researcher, WP4 and WP6 participant.

The researchers, PhD. Students and technicians involved in the project will be selected based on scientific/technical excellence criteria, without gender discrimination or any other

irrelevant distinction. The involvement of the female participants will be planned both at scientific/technological level and within the evaluation, consultation and implementation processes.

Following the EU directives on gender issues that consists in addressing the industrial activity towards a way of working oriented to equal opportunities criteria, the "Preservation, Safeguard and Valorisation of Masonry Decorations in the Architectural Historical Heritage of Piedmont" project responds to the EU request.

FINANCING TOTAL: 655178.99

FINANCING TOTAL PROPONENT: 636671.09

FINANCING TOTAL COPROONENT: 18507.9

