

Work Package: On site monitoring of mural decorative artworks using advanced ultrasonic techniques - Laboratory prequalification of injection grouts to be used in repair works

NUMBER: 3

TITLE: On site monitoring of mural decorative artworks using advanced ultrasonic techniques - Laboratory prequalification of injection grouts to be used in repair works

RESPONSIBLE: PIETRO GIOVANNI BOCCA

STARTING MONTH: 2

ENDING MONTH: 36

DESCRIPTION: Safeguard and restoration of mural decorative artworks are fundamental activities for the valorisation of Piedmont historical and artistic heritage.

A proper safeguard and restoration process must be based on a precise diagnosis of the initial degradation state of the artwork considered; subsequently the design of the most appropriate repair technique turns out to be crucial, as well as the selection of the most suitable repair products, in terms of durability and compatibility with the pre-existing structures.

In recent years, the Non Destructive Testing Laboratory of Politecnico di Torino – Department of Structural and Geotechnical Engineering – has started working in the field of Quality evaluation of innovative materials and their application in strengthening and consolidation of historical structures. Part of this research has been inspired by and applied to the biggest restoration intervention in Europe, i.e. Venaria Reale, Turin. It was aimed at the development of non destructive techniques able to precisely diagnose the causes, the characteristics and the time evolution of the degradation phenomena that could affect historical and artistic artworks. Differently than traditional ultrasonic techniques (that are generally considered to be insufficiently reliable for highly accurate diagnosis and monitoring applications) the Scaling Subtraction Method revealed to be particularly effective for this purpose, since it is able to capture the occurrence of nonlinear phenomena in the propagation of elastic ultrasonic waves inside materials, which are known to be strictly related to the presence of micro-cracks and early damage in general. Accordingly, WP3 intends to further develop the potentialities of this method in view of its future applications to damage detection and quantification in mural decorative artworks.

Moreover, in the perspective of the evaluation of repair products durability, WP3 aims to develop an innovative lab methodology for material prequalification. It is based on the use of mechanical tests for accelerated simulation of degradation processes and on the development of proper indicators of the mechanical behaviour for a preventive characterisation of material quality, i.e. durability under the effect of service actions. Uniaxial static and fatigue tests will be performed along with tri-axial tests, in order to explore the ultimate potentialities of the materials considered. In particular, the application of stresses acting simultaneously along different directions (with the of a specially conceived device that is being developed at the Non Destructive Testing Laboratory of the Politecnico di Torino) will allow to investigate some strength properties which have been hardly ever observed; in addition, while subjecting materials to particularly high stress levels, it will make it possible to test them in extreme conditions, and hence to define very strict and accurate prequalification criteria. A wide know-how is present at the Non Destructive Testing Laboratory concerning durability aspects and problems emerging in the use of repair materials in restoration and

maintenance of historical and artistic heritage in Italy. The proposed methodology will make it possible to predict potential anomalies in the interaction between original and repair materials, evaluate their efficacy and envisage their long-time behaviour, so as to guarantee optimal durability of the restored members.

OBJECTIVES: - Theoretical development, experimental implementation and on site application of innovative diagnostic and monitoring techniques based on the observation of elastic waves propagating in heterogeneous media in the sonic or ultrasonic frequency range. Among them, a specific methodology referred to as Scaling Subtraction Method will be regarded with special attention, due to its high sensitivity in identifying possible anomalies and defects inside heterogeneous materials, such as the ones constituting the functional layers of decorative artworks.

- Laboratory development of novel material characterisation techniques, based on the use of tri-axial static and fatigue tests, that will be performed with the aid of a specially conceived device in order to explore the ultimate potentialities of the materials considered and investigate some strength properties which have been hardly ever observed. In addition, while subjecting materials to particularly high stress levels, these techniques will make it possible to examine the mutual interaction between repair products and underlying support of mural decorative artworks in severe conditions, and hence to define very strict and accurate prequalification criteria.

- Accelerated lab simulation of natural degradation phenomena and mechanical/thermo-hygrometric fatigue effects usually occurring in mural decorative artworks, with the aim of evaluating the durability and structural compatibility of injection grouts used in decorative artworks repair under the effect of environmental actions.

- Definition of guidelines and technical protocols that could support public and private operators during design and execution of repair works in order to select the most appropriate restoration products and provide their preventive characterisation.

ATTENDED RESULTS: - Definition of a diagnostic investigation protocol to be used directly on site in order to evaluate the integrity of historical decorative plasters and their adherence to the underlying masonry support. Creation of a database of the results obtained using the proposed protocol, to be consulted by Piedmont public and private operators as a support tool in the process of valorisation and safeguard of the regional artistic heritage.

- Development of a laboratory protocol for the prequalification of materials to be used in repair and maintenance of Piedmont mural decorative artworks. Scientific and technical support to public and private operators for performing innovative laboratory tests aimed at identifying the most compatible and durable products in specific case studies and restoration works in Piedmont.

- Coordination of the research activity in cooperation with the other interdisciplinary WP of this project.

- Dissemination of the results, i.e. protocols, guidelines and scientific methodologies, among Public Companies and Territorial Divisions in Piedmont. Dissemination of the relevant scientific results among the international scientific community by means of specific courses and conferences.

Participant to the Work Package: On site monitoring of mural decorative artworks using advanced ultrasonic techniques - Laboratory prequalification of injection grouts to be used in repair works

AGENCY PARTICIPANT: (Politecnico di Torino) DISTR

STARTING MONTH PEOPLE ACTIVITIES: 2

ENDING MONTH PEOPLE ACTIVITIES: 36

PEOPLE/HOURS ACTIVITIES FOR PARTICIPANT: 1130

TOTAL PEOPLE/HOURS OF ACTIVITY On site monitoring of mural decorative artworks using advanced ultrasonic techniques - Laboratory prequalification of injection grouts to be used in repair works: 1130