

First Theme : Architectural Conservation within the System of Modernity

A. Policies of Architectural conservation and the ideology of persistent growth.

Problems of Architectural conservation in contemporary environments and its association with the concepts of endurance.

**AN OPERATING METHODOLOGY FOR DURABILITY AND SERVICE LIFE IN
RECOVERY INTERVENTIONS**

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ABSTRACT

The retrieval and change process of every historical built context, requires, without any doubts, a particular focus on all past memories as regards traditional building techniques and processes. And whereas such memories meet, it is possible to start some experiments of what today is the applying technical luggage related to the construction and building retrieval field.

The research concerns a study of the interventions of restoration realized in a sample area, ("Sassi of Matera"), so as to establish an operating methodology with interpretative and implementable rules for the assessment of the concept of durability and service life in recovery interventions, starting from the preliminary phases of recovery intervention.

The objective is to formulate implementable technical intervention sheets which are an indispensable means for intervention planning and programming, starting from an initial check based on validation of the choices made by means of on site experiments and laboratory tests that conform to the regulations in force, and from predictions of the useful life of the utilised components, technological and subject compatibility and maintainability of these components.

Intervention monitoring and experimental sampling of historical materials will allow to acknowledge faithfully how materials and building techniques must necessarily act as mediators and at the same time it will consider alternative, innovative and more sophisticated techniques as examples, in order to keep a good compatibility between past and present.

Keywords

Methodology, Durability, Recovery, Historical materials, Maintainability, Compatibility.

1. Introduction

The existent building heritage's retrieval holds the whole of the interventions aimed at preserving, recovering, rebuilding and using better the heritage itself. Through a recovery operation it can be added further value to the item of the intervention itself by means of, on the one hand, the former and partly lost conditions retrieval; on the other hand, by means of the details which are otherwise covered by stratifications settled on works, in order to protect the item against destruction, through its own re-utilizing and re-functionalizing. This operation can be meant as an aesthetic or philological retrieval of a manufacture's matter components.

Retrieval, with its physical and functional restoration operations, is characterized by the existence of the non cancellation petition of existing building heritage's historical natures (historical stratification or accumulation). It allows the readability through its identity changes (but non cancellations), and adapting the existing building heritage to the different needs which appear in its utilizing. The retrieval plan gathers structural, architectural, technical and functional aspects indissolubly. The need to integrate the building heritage's architectural and structural retrieval in a global view of architecture is a recent acquisition. It is opposed to the general and rushed extension to the pre-existent (in particular the historical one) of the safety, comfort and accessibility standards. Buildings can be adapted to these standards at the cost of heavy tampering.

Besides being the efficiency procedures choice of the required services, the retrieval plan becomes a precise study of user's service life and of the possible technical choices for their satisfaction coherently with the pre-existent's architectural features. For a "suitable" retrieval there is a correctness of the carried out choices, the overcoming of the case by accident logic, the non cancellation of the pre-existent's historical stratification and, finally, its adapting to the different needs which occur for utilizing.

The retrieval plan is therefore a complex instrument: on the one hand an expectation and communication instrument of the work to carry out, on the other hand a leading and checking instrument of the work's implementation. Starting from the planning phases, besides respecting many variables and qualifications which come into the retrieval, it is necessary to establish previously an assessment of the concept of durability method, namely the expectation of answers which guarantee, for a precise period of time, higher services than the conformed to regulations or customer's minima¹.

¹ I. Mecca, A. Guida, F. Fatiguso, Setting of the restoration project for durability, London ISBN 1-85312-968-2, in Atti Structural Studies, Repairs and Maintenance of Heritage Architecture VIII vol., pp. 705-714, Editor C.A. Brebbia, STREMAH 2003- Halkidiki, Greece 7 - 9 maggio 2003

2. Sample area: Sassi of Matera

The choice of the Sassi of Matera as a case study has come from various reasons. Here it is possible to assess the durability in recovery interventions through the (traditional and innovative) materials compatibility study and carried out or going to carry out interventions; through the quality and the service performance of the taken on intervention items and through a right maintenance choice. The Sassi of Matera² are an enormous historical and architectural heritage which is coming back to new life thanks to slight recovery interventions, after more than forty years of state of neglect and deterioration.



Fig. 1,2: The SASSI of Matera.

Due to largest deserted areas which are not restore areas, some on site experiments and checks have carried out in different environmental conditions and on every technical elements composing existing buildings. New materials have been experimented in building yard and then their results have been monitored assessing their services in different settings (completely carved hypogeum structures; carved and built structures; completely built structures) and types of buildings (monuments and widespread municipal building). Furthermore, in Matera it is possible to find ancient materials and building techniques, and even rocky civilization building features and rules with European towns' culture. The results of various planning phases succeeding each other for centuries have been assessed. In fact there is a strong interaction between architectural intervention and town- building, which is summarized in the typical connexions of every man's marks, of every architecture, to the land's complex orography.

The Sassi have a particular and extremely delicate ecosystem with a centuried balance between architecture and landscape. It has partly been changed by man, but this site's typical handcraft-delicacy needs a building maintenance in order to choose simple interventions which are respectful and in keeping with the area, but set aside by improvised planning "cultures". The Sassi of Matera are a

² In 1993 the Sassi of Matera became one of man's heritage, recognized by UNESCO in the "World Heritage List"

unique site because of its geomorphologic conformation, in which every deterioration phenomenon is strongly brought out by the existing conditions and the ten-year state of neglect. And therefore solving this areas' retrieval problems is equivalent to solve similar problems in other areas. In fact the Sassi of Matera are an intrinsically fascinating site, where every problem is as much as solvable. For this reason, experiments and following intervention choices are sound reasons, being easily extended to other apparently different areas.

3. Recovery interventions durability in the Sassi

Interventions' durability is linked to the new born elements' disposal to become integrated in the pre-existent building both dimensionally and functionally according to a particular service programme, namely according to a suitable compatibility. Considering the Sassi of Matera's values, the intervention suitability is not only the efficiency procedures choice of the required services, but it becomes a precise study about the customer's needs and the possible technological choices in order to satisfy them coherently with pre-existent's architectural features.

For the shape, typology and structure of the Sassi of Matera, the research has concerned the durability assessment in recovery interventions, carried out or going to carry out on the tufa wall with its trimmings. The Sassi architecture typological schemes come from the cave-house, a space set out by two parallel walls and an arched ceiling, a final wall made up of a mass of rocks and the façade made up of tufa blocks. "[...] *The house's structure is essential: two side-walls and a cylindrical vault carry out a "built space" while "rocky space" is in the caves, carved as underground passages towards the interior of the Sasso.*"³

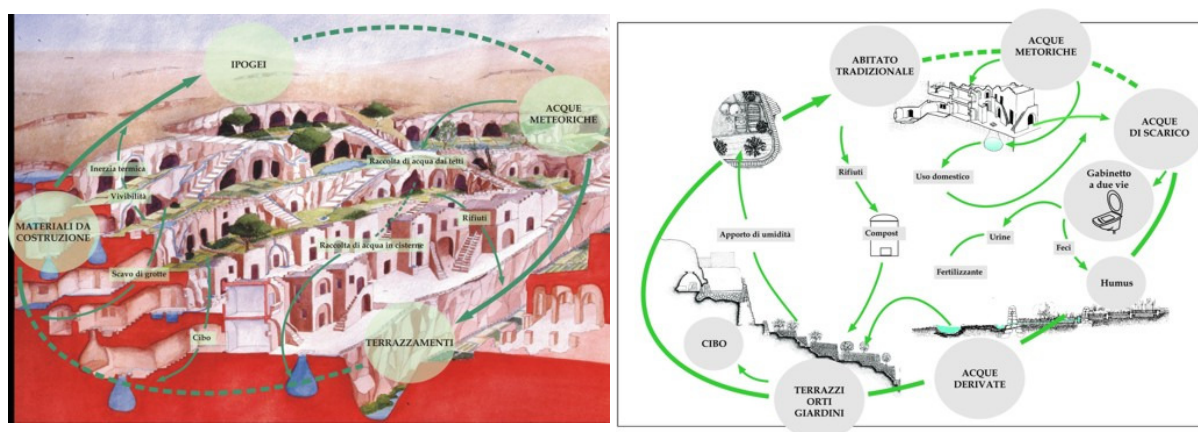


Fig. 3,4: Water circle and typological schemes

³ Giuffrè A., Carocci C., Codice di pratica per la sicurezza e la conservazione dei Sassi di Matera, Ed. La Bauta, Matera 1997, p. 78

This is the *elementary basis*⁴ of the Sassi architecture, a sub-space inside the following space. In fact even in the most developed houses, palaces and high-class architectures, built in later times with respect to the first housing-settlement in the Sassi, it is possible to find the same shapes and accessories typical of the cave-house. The houses in the Sassi can be considered as serial spaces made up of many elementary cells' union. These sub-spaces are the structural units which bring about smaller houses due to superimposition, simple approaching or different joining procedures to more complex spaces. This points out “[...] *the building structural regularity* [...]”⁵. In fact studying the house's walls, it can be found out the constant building-features of the walls which are the Sassi block of houses.

The building site is made up of a single material, the tufa. Everything is made up of tufa blocks, from the small decorative motives to the complete block of houses.

*"A single, but varied material forms the stone-town."*⁶

For this reason, defining the quality, reliability and durability of the single recovery interventions carried out on the houses' structural load-bearing elements (masonry and mass of rocks) both as for the structures and for hygienic recovery, is equivalent to solve most of the problems linked to the Sassi retrieval. In this case, the durability assessment in recovery interventions is strongly affected by the environment and the existing conditions and therefore by the site itself.

4. Operational methodology

In the second half of the last century, the way of thinking evolution changed the retrieval and restoration approach of buildings. Nowadays it is not only necessary to work on monuments, but “[...] *a more global idea of conservation has been acquired, including environment in all its functional and usable aspects.*”⁷ For this reason, the heritage to "recover" has become very wide. Most of the engineers have to work on retrieval procedure of the existent. The need for finding out a single planning methodology arises from this, in order to control the approach to the intervention by regulations.

This methodology consists of three important phases: the *introductory-trial* phase, the *building-technical* phase and the *running* phase.

In the operational methodology used in the present research to assess the durability on recovery interventions in the Sassi of Matera, even making use of the three phases, some phases have taken a great importance with respect to other phases, under the uniqueness of the sample area's features. The

⁴Cf. Caniggia G., Maffei G. L., *Composizione architettonica e tipologia edilizia 2. Il progetto dell'edilizia di base*, Venezia 1984, p. 161

⁵ Giuffrè A., Carocci C., *op. cit.*, p. 78

⁶ Giuffrè A., Carocci C., *op. cit.*, p. 78

⁷ Corbo D., Vassallo G., *L'analisi dei dissesti nelle strutture murarie*, Anno IV – N. 14 Febbraio/Marzo 1997, p. 50

introductory-trial phase has become predominant. It is not possible to work on any manufacture, if nobody has an introductory and complete knowledge of the intervention's item and its own conditions.

The intervention cannot ignore the knowledge:

- ✓ of the area's geologic and geomorphologic aspects. In particular the Sassi which are a carved architecture, with the thickness and change of various outcrops (such as limestone, calcirudite, calcarenite). In fact the house have been carved and then built inside the last stratum;
- ✓ of the soil - structure interaction: such as soil's features, checked in the past or likely effects;
- ✓ of the block of houses' typology and introduced by man changes; during the population increase the town-building underwent several changes and single houses were changed and enlarged;
 - ✓ of shape and size: survey of every element composing the intervention item;
 - ✓ of the building elements' typology: mudsills, masonries, floors, roofing;
 - ✓ static-building-knowledge: possible tumbling down, tampering, reconstructions, important reinforcements, assessments on static behaviour of the building;
 - ✓ of materials: physical and chemical features and strength of used materials;
 - ✓ of building techniques: how to join traditional materials together, namely the existent materials;
- ✓ of the calcarenite mass falls and deterioration: slips and fractures due to natural phenomena and state of neglect;
- ✓ of the recoverable item's deterioration (hypogeum, elevating structure): new static balances due to mudsills' sag and vaults' thrusts. The deterioration is due to the state of neglect (lack of ventilation, obstruction of the natural flow of the water and therefore mildew, mosses and natural vegetation at a high level of humidity);
- ✓ of previous results on site experiments and lab- or on site tests in order to provide for missing and inadequate data;
 - ✓ of the intervention's carrying out; planning ideas' proposal and assessment;
 - ✓ of the monitoring of the operating activities carried out during the intervention (diagnostic analysis, building yard's productive parameters, planning activities, etc.);
 - ✓ of the intervention's validation: new tests to assess the intervention's positive result;
 - ✓ of a maintenance programme planning.

The existing survey and its study, tests and experiments, namely the intervention's item complete knowledge (monument, municipal building), are the main conceiving chance to recover and /or restore the plan.

5. A new diagnostic campaign

The need for planning and programming a lab- and on site campaign of new tests and experiments has arisen from the data, on the one hand, coming from previous tests and experiments campaigns carried out in the sample area on traditional and new materials used in recovery interventions. On the other hand, data coming from the even only visual assessment of the first carried out interventions.

Some technological tests have been carried out. They were intended to settle the physical, chemical and mechanical features of the materials used in the carrying out of the Sassi houses' (tufa, mortar, plastering) in order to assess the used materials' (physical, chemical and mechanical) compatibility. If necessary, it is possible to use new materials during restorations and also for the choices carried out during the interventions, as in the case of using a specific inorganic reinforcing agent of the rocky mass or typical dehumidifying plastering.

The lab-interventions programme has provided:

- ✓ determination of the siliceous and/or silicates aggregate's content: it measures the quantity of siliceous and/or silicates aggregate present in the sample (Alessandrini method);
- ✓ determination of soluble salts sulphates, chlorides and nitrates' content: it measures the quantity of salts present in the sample through the UV-rays input; X-ray diffractometer: survey of the diffraction spectrum created by a crystalline material when it is flooded by a X-rays beam. It allows the crystalline substances identification;
- ✓ thermo-gravimeter analysis (TGA): it measures the attemperation related to a change of weight (loss of weight);
- ✓ differential scanning calorimetry (DSC): it measures the temperature related to the difference among heat flows;
- ✓ scanning electron microscope (SEM) analysis: it allows to observe and mark a sample's surface; it allows to acknowledge the physical nature and the solid's surface chemical composition; on a sub micrometer scale;
- ✓ determination of porosity: it measures the volume of the existing vacuums inside the material, but accessible from the outside (mercury porosimeter);
- ✓ absorptance: It measures the quantity of absorbed water by a sample.

This campaign of lab-tests allows engineers to acknowledge the materials' chemical and physical features and it also helps to settle its mechanical characterization, defining its porosity. Furthermore

these tests allows to get information about the compatibility between traditional and modern materials, as well as about the surface-deterioration nature. Experiments and new structural tests have been planned both on masonries and mortars. These two technical elements, because of their own physical and chemical nature, are the cause of rather serious pathologies in the analyzed building context.

The programme of structural tests has provided the carrying out of:

- ✓ squashing tests to settle the breaking test load and to assess the differences related to the origin;
- ✓ creep tests to settle the breaking test load for a material subdued to a steady load.

A theoretical calculation pattern has arisen from these tests results: for the first time on calcarenite structures, in order to settle the evolution of masonry's damaging, getting the percentage of the first structural damage in comparison with the material's breaking tension. It can be drawn a line method which correlates the damage to the tension and therefore the possibility to settle the pillars and columns reinforcement scantling, applying the tension to the line method.



Fig. 5 - 8: Creep tests

The tests on mortar (Penetration meter test) have been carried out on site by means of an instrument, planned and produced by the University of the Basilicata Material Tests and Structures Laboratory of the Di.S.G.G (Structures, Geotechniques and Geology applied to Engineering

Department). This instrument settles the mechanical features, the angle of friction and the screen curve of the traditional and modern mortars, which have been used as a result of a reinforcement intervention carried out on several monuments in the sample area: and therefore it is possible to check the carried out intervention's efficiency. The aim of the tests is to correlate the numbers of strokes per a penetration millimetre (Stokes per Penetration Unit) with the sanded mortar's quality and some mechanical features such as the "angle of friction", in order to check the only frictional strength of the penetration meter point related to the vertical pressure, ignoring the cohesive component and the "thickness of the joint". Experiments on historical mortars and also on modern mortars of the joints betterment or the dismantling-assembling have been carried out.



Fig. 9 – 11: Penetration meter tests

6. Conclusions

This precisely planned survey is a further instrument of knowing and programming every recovery intervention, with respect to the ancients, without compromising durability and safety requirements.

The aims within reach are the following:

- ✓ providing useful elements to assess or not the need for a reinforcing and/or recovery intervention for the analysed building typology. If it is possible, having the operator trained in the suitable solving;
- ✓ Providing, comparing the data, before and soon after the intervention, the possibility of assessing if the intervention has reached the expected results both as for the intervention's safety and durability;

✓ sharing a lot of available data, drawn from lab- and on site tests and experiments in order to give an important aid to research in retrieval field, trying to reach a characterization of this building typology.

This research can help to increase the building test survey; in fact relating to the problems which can take place in a campaign of tests and experiments, a single type of survey will be not enough, but there will be an organic plan where it is possible to compare the different surveys' results. Using this methodology, comparing the data coming from different surveys, It is possible to explain real phenomena and providing the parameters necessary to carry out a correct intervention.

Chapters 1 and 6 by both the writers.

Chapters 2 and 3 by Prof. A. Guida

Chapters 4 and 5 by Eng. I. Mecca

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