Setting of the restoration project for durability

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Abstract

This research intends to analyse the interventions of restoration (of both traditional or innovative techniques, and of natural and synthetic materials), aimed at predicting the durability of useful life and acceptable state of the components and buildings in conventional, normal conditions. Technological integration must be verified on different levels of comparison and appropriateness of choices, with innovation that respects the "ancient" plant and construction systems, and re-assesses and exploits the natural resources; water, air, light and space, in accordance with the building traditions of the Mediterranean basin (the "Sassi of Matera"). The aim is to establish an implementable methodology for durability of the interventions, based on a quality approach for the various phases of the building restoration process, and implement an interdisciplinary project between tradition and innovation, defined by the needs of the building structure.

1 Introduction

Approaching building and environmental restoration assumes an awareness of the fact that human intervention may lead to irremediable fractures in the continuity of the territorial, historical evolution or cause irreversible degradation of the environmental resources that are subject to excessive or irrational exploitation. On the other hand, since any human intervention, as correctly planned as it might be, inevitably leads to a change in the environment, it is necessary to ensure, from the initial planning phase, that such changes allow new

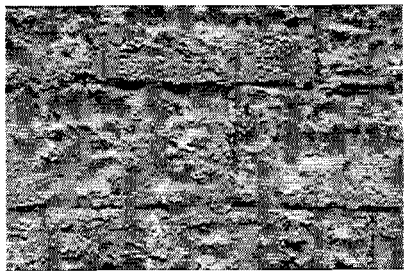
acceptable equilibriums to be established and that using the resources will not compromise the reproduction capacity. An assessment of the different components must be integrated into the general planning procedures of all of the work that is likely to alter the initial environmental conditions considerably because of its nature or the characteristics of the area in which the work is to be carried out. From this point of view, the research intends to define a methodological approach to identify interpretative and implementable rules to assess the concept of durability in restoration interventions, starting from the preliminary phases of intervention, therefore, that is from the project. In particular, it is intended to assess the durability of the restoration intervention, analysing the aspects of subject compatibility, technological integration, performance harmony and programmed maintenance. 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, the objective is to formulate implementable, technical, intervention sheets, which are an indispensable means for intervention planning and programming. With the present work underway, the next step towards defining this approach for durability of the restoration interventions is to be faced, principally relating to the initial research phases.

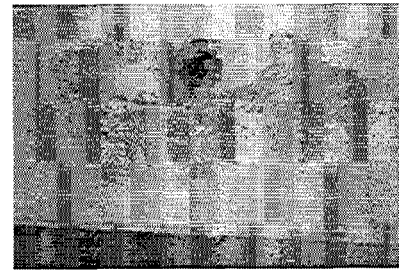
2 Durability of the restoration interventions

In recent years the transformation (despite being slow, documented in literature [6], from the quality of the materials, elements and objects forming a building structure to the quality of performance of the constituent parts and products, has aroused interest and studies for durability not only of the components but also of the entire building system. The difficulty in assessing the useful service life of a building and restoration intervention due to the high number of variables that come into play, as well as the scarce knowledge of the relations existing between them, imposes the need to define an operational method, that, starting from the assessment of the useful service life of the materials (above all, in particular conditions of use) also allows determination of the service life of the whole intervention carried out. In this assessment the intensity of the atmospheric agents and the deteriorating action of the time exposed, in other words, loss of physical, chemical and geometric characteristics of the material must be related to the service performance of the material. A reduction in the life span of a building structure is linked to phenomena of obsolescence of the parts constituting the structure, that is ageing, degradation and deterioration, in relation to which there is a decline in the levels of performance and quality. The obsolescence, as is it known, may be physical, functional and technological [7]. All phenomena of obsolescence influence the useful life of a building, making it necessary to set up checks for the requisites of durability, maintainability and reliability of the building components. Most of the time, the material, composing these structures, is correlated to preserving the working state of the components

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that constitute the buildings. However, this interdependency is strongly linked to compatibility or incompatibility that is determined by the association and assembly of the materials used, since these do not function autonomously, but interact, and when faced with mechanical, physical or chemical incompatibility, may have combined reactions that may trigger effects of serious degradation. Nonetheless, the materials are assembled and combined depending on their individual physical characteristics, in time these can change, to such an extent that they produce combined reactions with undesirable effects that may even by serious. These alterations may be of an aesthetic nature but also of a physical one, enough to result in damaging the buildings with phenomena of a considerable reduction in the operational life cycle of the structures.





Figures 1 and 2: Examples of physical and chemical alterations.

The durability of a building structure and restoration intervention is determined by the capacity of the material, constituting the structure, to last in the course of time, resisting the aggressive action of the environment, guaranteeing the performance for which it was designed. Durability of the material is, however, a necessary condition, though it is not sufficient to guarantee durability of the entire structure: there are causes of degradation of the structure that may not be blamed on scarce durability of the material in that it is an autonomous element, though, sometimes it may be blamed on poor compatibility of the materials used and bad workmanship, or on structural incompatibility. In fact, if the creation of a building structure by assembling different elements and materials does not cause particular problems, the same cannot be said for the creation of a building structure of pre-fixed quality and, in particular, of programmed durability: the different reactions of the constituent materials and, at times, the decaying process of the quality of labour on building sites and restoration relating to constructional techniques which, have become more sophisticated in the meantime, makes the second objective even harder to achieve.

3 Restoration project for durability

As with any building project, a restoration project is a complex instrument, on the one hand because of the predictions and communication of the work to be carried out, and on the other, because of the guidance and control of its

execution. Generally speaking, assessment of durability in the planning phase means predicting solutions for a specific period of time in order to guarantee performance that is superior to the minimum requirement by law, in other words, by the client. In order to achieve this, the planner must devise solutions (relating to the material, techniques and technology) with an initial "performance surplus", guaranteeing minimum agreed levels within a fixed period, taking into account the degradation curves and possible maintenance interventions. This surplus may not be very great for obvious reasons of finance and overall sustainability of the intervention. Definition of the initial performance surplus to guarantee durability of the intervention essentially depends on the knowledge of ways of performance degradation of the different technical solutions. For building restoration, and specifically, historic areas, the action scenario is complicated for various reasons. Using the same material, or material that is similar, nowadays extracted from quarries using different technology and procedures, and assembled using a building technique that is compatible with the original one, may extend the useful, operational life of the restoration intervention, thus increasing durability. In some cases these same techniques used in areas that are particularly disadvantaged from an environmental point of view, do not give the same results, indeed, they prove to be less efficient than interventions using apparently incompatible material and building techniques. In fact, if traumatic damage caused in building structures by extraordinary events such as earthquakes, fires and wars are excluded, "natural" damage may be classified into deterioration of a physical, biological or chemical nature according to the prevalent mechanism of degradation. These mechanisms of degradation always include interaction of the material with the surrounding environment, even more so in places that are particularly sensitive, such as in historic centres. And it is indeed in this particular context that support of the indirect practices are necessary, finding foundation in the diagnostic investigations, highlighting the results obtained on the experience of pathology analysis, identified in specific areas, and on interventions based on the adoption of some technologies and products on which the impact has been verified in time. The research in progress is developed according to a programme that anticipates different phases, which may be essentially identified in a collection and study of bibliographic and technical documental material relating to durability of the interventions on buildings of particular historic value and to an analysis of the interventions carried out on a sample area. The analysis phase foresees definition, study and elaboration of the criteria for planning of the preliminary investigations using experimental methods, equipment and techniques of the specific urban habitat, by acquiring information that is useful in compiling the planning requisites, relating to insertion and contextualization in a physically determined and culturally characterised environment. With the support of the interventions underway and already finished in the sample area of the Sassi of Matera, and with the procedural indications of the Practice Code [2] and Restoration Manual [3] for durability and compatibility of the restoration interventions, it is intended to proceed with assessing and validating the choices for the intervention of restoration depending on the maintenance. Assessment is carried out using instruments of Design for Durability, in other words, by

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establishing the relationships between indoor performance, technological performance of the physical and characteristic parts of the material, assessing the reaction of the solutions adopted in the course of time, verifying the reaction of the individual parts in relation to useful life of the building with predictions of strategies and scenarios for maintenance, thus enabling the project to be assessed, in other words correspondence to the needs for use in the course of time. One of the objectives of the research is to assess the durability of the restoration interventions in a sensitive ecosystem that is particularly worn down by the abandonment in which it finds itself, both on a material level, that is, of the materials used or usable for the interventions carried out or to be carried out, on a level of technical solutions and/or technology, and on a level of structural integrations to adapt the houses to the current housing standards, and again assess the performance harmony of what has been carried out so far and what is to be achieved. The final result of the work, that is currently underway, will be the formulation of technical sheets to be implemented for intervention and relative, maintenance programmes (indispensable means for planning interventions) worked out on the basis of a careful programme of monitoring the procedures, materials, and adopted, building techniques, despite being limited today to small areas and sample cases.

4 Sample area: the Sassi of Matera

The Sassi of Matera constitute an enormous, architectural heritage abandoned for over fifty years and today the scenario for operations of slow restoration, under the patronage of UNESCO

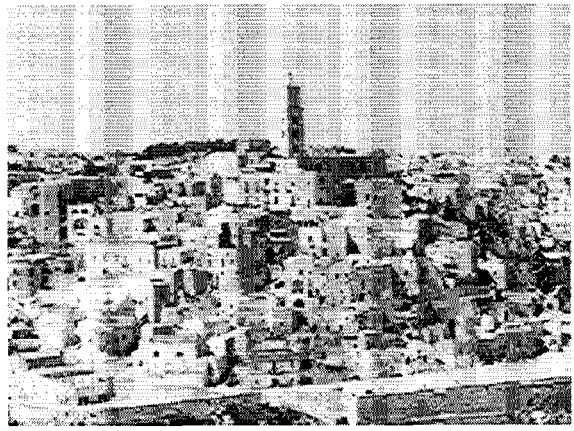


Figure 3: The Sassi of Matera

Ancient Matera was, and still is today, a hidden city. At the top, is the Civita, with its architectural protrusions, houses to the north and south, severe-looking buildings and courtyards reaching out to form the Sasso Barisano and the Sasso

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Caveoso with Casalnuovo. The subsequent changes in climate and landscape, together with the drastic alterations in the social organisation of the population, is reflected in the evolution of the handiwork and dwellings. Natural caves, hypogean architecture, cisterns, farmhouses, enclosures, churches and buildings, following on and co-existing, dug out of or built into the tuff. Such diverse settlements coming together with the common aim of exploiting the difficult geographical conditions as best as possible. The forms and types of built architecture originate from the caves. The cavities penetrate deep into the rock following the layers of limestone. Multiple levels of hypogea are created, superimposed by long tunnels, sinking sideways into the subsurface. The sloping ground enables the sun's rays to penetrate deeply, thus aiding aeration. In the winter, the sun reaches its lowest point on the horizon, and the excavations, that plunge into the depths with a calculated course, gathering all of the radiated energy, are used to store the heat. The various levels of hypogea are connected internally by wells and *vertical aeration devices*. There are over ten levels of superimposed caves, with tens of bell-shaped cisterns, joined by canals and water filtering systems. The side by side, superimposed *"vaults"* form dwellings, consisting of several rooms and floors. The roofs of the houses below reach the edge of the upper terrace that extends on to them by a road or by the gardens of the houses opposite, so determining the urban landscape in the form of sloping terraces.

4.1 Restoration: intentions and realities

The impact of modernisation on such a delicate ecosystem can also result in damage: the numerous studies and research carried out in recent times, testify the need felt to handle building and functional restoration of the Sassi of Matera with an understanding of the urban environment, defining a cultural orientation, a code of behaviour that enables this architectural heritage to be relived, taking into consideration all of the needs linked to modern living, without altering its character, using interventions relating to the original structural, typological, functional and technological features, paying particular attention to the maintenance of new intervention. Moreover, on the one hand, the individual features of the Sassi – a tiny, building network, gathered around enclosures and along access balconies, alley-ways, large steps and streets, and, on the other, the quantitative dimensions of the restoration work, which has already arduously been started in part, forcefully place the methodological problems of intervention onto what is already existe. The operational reality indeed proves that in many cases, the problems regarding re-use have been faced by changing the consolidated methods of interventions for new building and by applying functional and/or technological solutions which have already been experimented on new buildings but which are not gauged for insertion into historical contexts. Thus, restoration has been resolved by adapting the building units with transformations and forced introduction of new elements and functions that have altered the original typological and morphological attributes, setting the achievements indeed far from the initial theoretical requirements.

4.2 Between tradition and innovation

For some time considerable research concerning the various aspects for restoration of the Sassi of Matera has been carried out, particularly concerning the problems linked to achievement in the field of functional housing restoration rather than in environmental comfort – interpreted as a series of magnitudes establishing the relationship between the outside world and human sensations, therefore referring not only to exchanges in temperature, humidity and air purity, but also to acoustic and tactile sensations, to the optical field and especially to needs of a psychological, aesthetical and social nature -, which constitute one of the principal cruxes of this restoration work. More specifically, the research has already dealt with the aspects linked to hygienic environmental rehabilitation, monitoring systems and non-destructible evidence for indoor quality control, as well as the appropriateness of planning choices [4] [5]. In this context, the attention focuses on the impact of modernisation in restoring ancient buildings, on the effects of the restoration started in recent years, and on the consequent risks of such transformation. Added to these immediate risks, are those linked to the choices of the building materials and techniques, which, again, are related to assessments of durability and relative useful life cycle. This is confirmed by the fact that, compared with new buildings, it is certainly more demanding to accomplish integration between the needs relating to environmental performance, required by the development of specific activities and architecture, as it is difficult to manoeuvre the variables of the structure, systems and functional project simultaneously, combining them with the same architectural language. Such integration must be seen as an interdisciplinary, methodological approach between tradition and innovation, based on an accurate study of the needs expressed by the user and the feasible, technological alternatives to satisfy them, in keeping with the values expressed by the buildings. Indeed, a knowledge of the materials and building techniques used, is fundamental, as is knowledge of the structural systems adopted, in order to succeed in maximum exploitation of the area's natural resources, in order to be able to carry out suitable interventions, verifying the appropriateness of the choices, from a material, static, functional and technological point of view. In this case, durability of the interventions is linked to the ability of the newly introduced elements to integrate dimensionally and functionally into the pre-existing, building structure in accordance with a specific, performance programme, in other words, in accordance with suitable compatibility. In particular, an aspect linked to formal, structural and functional compatibility of the interventions for technological adaptation will subsequently be analysed.

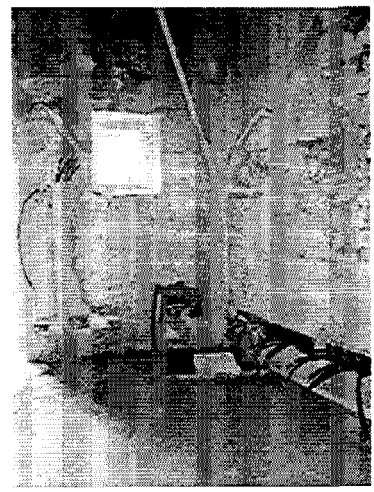
5 An aspect of durability: formal, structural and functional compatibility of the interventions

In the event of needing to carry out a check of the internal, environmental qualities and comfort using a "traditional" approach, based on functional, technological, adaptation of the building heritage of the Sassi of Matera, this

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must be a specifically planned intervention, which as its objectives, sets the well-being of those people living and working within the environment, as well as, simultaneously safe-guarding those historic, cultural and architectural values, linked to a skilful choice of materials and forms, that is, the result of compatibility and durability assessments. However, the operational reality proves that this does not occur: formal, structural and functional compatibility between the particular architecture of the Sassi, and technological services is often sacrificed in order to respect consolidated standards and practices. The research proposes an integrated approach, in which "traditional" technological equipping of the environments in the Sassi of Matera, that is, the introduction of elements of the structural sub-system, connected to satisfying the performance requisites for a contemporary quality of living, is verified jointly on different levels, with a comparison of consistency and appropriateness of the choices made. In the case of the Sassi of Matera, for example, the problems concerning the introduction of technological services may be traced back to a more general integration process, between the building equipment and structural sub-systems. On a general level, it is possible to claim that globality of the methodological approach is necessary, as it is based on the adopted attitude regarding the restoration, which is of priority definition for performance, requisites and subsequent identification of the action to be started; action that may vary depending on the needs, and which may, therefore, not be generalised. In any case, the approach to spaces must pursue an elevated control for consistency in relationships, and also environments of "minor" use or reduced visibility by the users, rejecting classification of the spaces, based on the decorative-spactial-formal characteristics, and also based on the specific new use, type of use and visibility of the environments. On the basis of systems of values for the "Sassi" of Matera, consistency in interventions means much more than simply choosing the conditions for handing back the requested performances; it means an accurate study of the needs expressed by the user, and feasible, technological alternatives to carry them out, in keeping with the architectural characteristics of what already exists. With regards to the main procedures for action, to carry out intevention of technological equipping, it must be noted that these have already been classified in a different context [4]. For example, the superimposition of distribution networks that completely disregard the original structures – resulting in the impossibility of establishing any kind of relationship, after a complete lack of control of the equipping process- creates a clear contrast between the technological services and the particular architecture of the Sassi, which does not strengthen and resolve the ancient/new dualism, but which increases the sense of opposition and scarce involvement, marking an interruption in the continuity of the processual logic of the environment of the Sassi. And it is indeed this interruption in continuity, that leaves its mark today, at a distance of only a few years, since the first radical interventions for restructuring, restoration and refunctionalisation of these hypogean settings were started, that leads the present study towards a systematic collection of "fractures" and "discontinuities", in keeping with the language of environmental respect.





Figures 4 and 5: Examples of structural insertion. The figure on the left at the bottom shows the mark of a pre-existing chimney flue from a wood-burning cooker, which may be reused for new pipes. Instead, on the right, is an inadequate structural insertion.

Durability of the thus identified interventions leads to the consideration of residential "inconsistency" in general, correlated to structural, system and environmental implications. The numerous studies carried out in the field of durability and useful service life of materials, structural components, and building products are essentially aimed at the sectors of new construction as a result of great incentives and interest from the industrial sector. The greatest difficulty in restoration originates from having to conciliate different building techniques and diverse materials, which are, at times, apparently incompatible and contain a discrepant useful service life, and even more importantly, one of the greatest difficulties comes from trying to reproduce, what has been experimented for new buildings, onto "ancient" or "historic" structures, regardless of the inappropriateness of the adopted choices, consequently disrespecting the physical-formal-functional and chemical equilibrium that has been consolidated for years in this particular urban system that was created many years previously, and which perfectly resembles the rupestral character of the territory in its unique form of "architecture in a negative sense". In the course of time, man's intervention has altered the original, geomechanical environment, enough to render it variable in space and non definable in detail, since it is an expression of multiple parametres of a different nature. [9] Therefore, planning approaches that do not underestimate the environmental factor must be considered, determining experimental and validated interventions in the evolution process of the Sassi of Matera, which may be established as a more respectful direction for the architectural characteristics of the building heritage concerned.

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6 Conclusions

The problem of integration between tradition and innovation to upgrade the residential settlements in the Sassi and safeguard the ancient typological and urban structure, must take into account the architectural, typological, original and intersecting, structural framework aspects, in order to optimise residential-performance quality and keep the equilibriums intact; equilibriums that have been consolidated over the centuries for the *"city of water, light, air and gardens"*. The research, that has been set out up so far, aims to offer technological elements, that bring the residential and housing standards back to today's required levels, reducing to a minimum the risks of compromising the historic craftwork, fully respecting the equilibrium of the existing materials and innovative and traditional building techniques. And it is only by considering the impact of modernisation on an ancient context such as this, that the subject of intervention durability will necessarily pass through the control and mastery of traditional building techniques and a "programmed" design, in keeping with such interventions. The objective of the intervention must be to guarantee linguistic continuity of the landscape of the Sassi between its past and future, humbly respecting an environmental heritage of great value.

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