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Thematic Keynote

Planned preventive conservation and the structural performances of buildings

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ABSTRACT: The paper aims at illustrating how the practices of planned preventive conservation may interact with structural behavior of old buildings. First, the effectiveness of regular maintenance will be underlined, also referring to preparedness to seismic risk, and other major risks as well. Many proves have been gathered that vulnerability increases as the lack of maintenance leads to decay of devices, such as iron or timber ties, which were required by the original structural conception. Second, preparedness to risk has also a top-down meaning, traditionally expressed in tools like risk maps used for support to decision making. Mass-screening of vulnerability has already been implemented as a practice capable to reduce the impact of natural hazards, as for instance earthquakes and storms. These tools can be used for enhancing programs and therefore the quality of interventions. Third, as the understanding of preventive conservation has been enlarged by the latest researches, the theme of uses compatibility evaluation is included, considering carrying capacity and loads, or safety and strategic functions.

1 INTRODUCTION

Conservation of built cultural heritage can be characterized as "planned and preventive" when it is understood as a process, which has to be dealt with thinking on the long run and never focusing on single acts. Preventive Conservation concept has been developed in the last years also for built heritage, exploiting the idea of prevention itself (Van Balen 2015) and the research carried out in the field of museums and collections (Staniforth 2013), which made a broad use of the concept of risk management (Waller 1994, Ashley-Smith 1999). This shift from collections to buildings implied several reflections on the issues related to use and on the economic impact of conservation, leading the research towards further edges on community involvement and integrated political agendas (Della Torre 2010, Van Balen & Vandesande 2013, Van Balen & Vandesande 2015a, Van Balen & Vandesande 2015b). Nevertheless, the core of the strategy can still be investigated under many points of view, and above all it has to be implemented more and more in many contexts, as practitioners and decision makers still tends to ignore the potential benefits of a farsighted strategy.

In Planned Preventive Conservation frame, conservation is deemed to become more effective in a long period perspective as the various kind of interventions (monitoring, maintaining, repairing, strengthening, restoring, reusing, restructuring, reconstructing…) are not meant as progressive levels, but as phases of one cycle, embraced by a comprehensive program. Sir Bernard Fielden defined seven degrees of intervention, i.e.:

1 prevention of deterioration (or indirect conservation),
2 preservation,
3 consolidation (or direct conservation),
4 restoration,
5 rehabilitation,
6 reproduction,
7 reconstruction (Fielden 1982).

The point is that we should not simply chose the right level, keeping in mind the principle of minimum intervention, or "less is more". We should always think that each intervention belongs to a long term process, so that we will maintain tomorrow what we are restoring today. Furthermore, the necessary combination between direct and indirect conservation, as the intensity of the intervention, i.e. of the change induced in the historic fabric or the risk of loss in authenticity, depends on the external agents, and an effective preventive conservation design led sometimes to implement some control on them.

Put otherwise, conservation is a systemic problem, which requires a complex strategy. The toolkit for conservation requires to be widened. Perhaps the most important statement is that no tool (maintenance plan, design, program, conservation plan, etc.) should be chosen without thinking it as a part of a set of tools arranged as integrated procedures.

2 PREVENTIVE CONSERVATION AS INTEGRATED PROCEDURE

The first and simplest impact of preventive conservation is conceived to be a better maintenance of the building system. Here again the word "system" has to be underlined, because also for the structural performance versus exercise loads as well versus

other actions (wind and storms, seismic actions, etc.) depends on the strength of some load-bearing elements, but that strength could be spoiled by a poor state of repair. Many proves have been gathered that vulnerability increases as the lack of maintenance leads to decay of devices, such as iron or timber ties, which were crucial for the original structural conception, guaranteeing the box-like-behaviour of masonry buildings, but water leaks can also corrode the binder of mortars worsening the capacity of bearing vertical loads.

That's why regular maintenance is deemed to be the basic way for an effective preparedness to seismic risk, and other major risks as well (Stovel 1998). It has been argued that in the case of disasters the main risk gives the way to many other collateral effects, which may be dealt with as other risks in the form of a failure-chain: e.g., after an earthquake buildings are often damaged in the roofing, so that they are exposed to weathering, and the technical plants get often damaged causing the risk of fires. There are also risks also for movable heritage, spanning from exposure to weathering agents to vandalism and thefts.

This suggests a multi-hazard approach, taking into account also Climate Change effects (Schmidt and Ravankhah, 2014), and this confirms that a careful management is also useful both to avoid these damage-chains, which often magnify the effects of disasters, and to improve resilience. On one side, it is worthy to remind that damages induced by quakes are not only major structural failures, but also smaller damages on secondary elements (chimneys, decorations, statues, projecting elements, etc.), which are often vulnerable because they lack any safety device, or the devices have not been maintained. On the other hand, if regular maintenance is carried out following the models applied to an organization, identifying people, tasks and skills, the activities of this organization will be a powerful resource for resilience to disasters induced by natural hazards or other negative events.

3 THE QUALITY OF THE PREVENTIVE CONSERVATION PLAN

3.1 *Conservation design set for future maintenance*

In the Planned Preventive Conservation frame, the maintenance system traditionally includes inspections and condition assessment, monitoring and small repairs, but is not thought separately from the evaluation of the need for more important interventions, aimed at improving the use of the premises or to prevent major risks. Furthermore, management, maintenance and prevention are taken into account just in the phase of designing interventions.

According to the definition given by Italian Heritage Code 42/2004, prevention "means the set of activities useful to limit the situations of risk concerning the cultural property in its context". Preventive actions are often directed on the context, limiting external actions, so that the input to the design of direct interventions can be less severe. In other words, in order to minimize transformation and to maximize authenticity the designed intervention is split acting more on the context and less on the historic building.

On the other hand, a way to make the intervention less intrusive is to design also the maintenance plan, or better the conservation plan, which includes data storage and scheduled operations, but above all a careful design of the most respectful modes of using the rooms and caring the surfaces. In this way, it is possible to control also troubling issues, as for instance the enhancement of energy efficiency, which is often a difficult problem to solve in historic buildings, according to the new claims for a one-dimension sustainability.

In other terms, the way of thinking related to preventive conservation approach requires a radical change of the designer's attitude to conservation. Therefore, it is necessary to move the accent from design to the phase above, i.e. to the program phase, which is the phase when decisions are taken, imprinting the targets of the intervention, the quality of the works, the adequacy of the management system (Della Torre 2015). Program is the phase when the needs are identified as well as the state of conservation of building is assessed, evaluating the compatibility among the often new function and the historic building, in order to fine-tune the conditions of use or design changes in use and layout or to evaluate adaptation of the structures. The destiny of the building has therefore to be clarified at once: it often proves to be wrong to restore a property without a clear vision of the future management conditions, because this means rejecting the help of alternative strategies, ending up in shortsighted solutions. This means identifying stakeholders, with their different views, building alliances in order to arrange a feasible business plan, building strategies for valorisation and funding. What counts here, this wide and long term vision implies deciding about the quality of design, works and maintenance plan.

3.2 *Building vulnerability assessment*

Without a deeply discussed program, it will be difficult to set up innovative practices, like scheduled maintenance or a tight control of the uses paying attention to the carrying capacity of the property. Anyway, here the focus is on quality (Van Roy 2015), meant as the correspondence of the works and/or the structures to the requirements and the performance level. It is important to point out that a program developed under the guide of skilled professionals can be effective in steering the attitudes of all the involved players towards a better understanding of their tasks and of the specific characteristics of historic buildings.

It is well known that technicians, including architects and engineers, are often accustomed to work on new structures for modern needs, and are not ready to doubt about requirements, standards and ready-made solutions, whilst historic buildings require sympathetic investigations of their materials, memories, constructive logics, in order to find even new ideas on how to exploit hidden resources. An example may

be that of Local Seismic Cultures theorised by Ferrigni (Ferrigni 2005): some very important structural details could be neglected or misunderstood without a specific knowledge background, which needs to be built by accurate and patient investigations. This point links conservation planning and the management of significance: the attention paid to heritage buildings as structures has already developed an interesting research streams about archaeology of architecture and history of construction, which enlarges the reasons that inspire the attitude to a more careful conservation, extended to the details that witness traditional building culture.

The deep knowledge fundamental to this approach is also the best antidote against the risk of exceeding in strengthening a structure, inducing a loss in authenticity but sometimes also a bad overall behaviour of the ensemble produced coupling old and new elements. Knowledge and care enhance the designer's awareness, orienting the projected works towards more compatible solutions. By the way, compatibility should be also a matter of managing border conditions, as incompatibility may keep potential until external conditions start the undesired processes (Smars 1998): this drives back to splitting attention and operation both on the object and its context, also introducing management as a very important tool in a long term vision.

Compatibility is therefore a key concept, along with the sympathetic understanding of the historic structure, and the awareness of the generally accepted deontological principles of conservation. These ideas lead to a fundamental definition introduced for seismic retrofitting, but valid also in other fields, which is the concept of improvement ("miglioramento" in Italian documents) as opposed to adaptation ("adeguamento" in Italian documents). The term improvement is used for interventions that work on the structural conception of the existing building, aiming at a better performance without changing the behaviour, while the term adaptation refers to a full compliance to standards, which sometimes are applied unthinkingly leading to interventions signed by an incompatibility which increases vulnerability.

The earthquake which in 2009 struck L'Aquila damaged a lot of ancient buildings which had already been rebuilt and modified after previous events, as the big one in 1703. An interesting case study is the church S. Maria di Collemaggio, which in the 1970s had been restored getting rid of the aseismic Baroque solutions, ending in a highly vulnerable slender structure which had severe damages. On the other hand, a XVIII c. palace, which had been built with careful implementation of seismic culture and had been slightly improved few years before 2009, just introducing a set of iron ties, had minor damages (Lucibello 2013). The cost of the repairs were not negligible in this case, but undoubtedly the ties proved to be a good investment.

The latter example could also be developed for an evaluation of the overall convenience of preventive improvement, which aims at saving human lives but has not the presumption of making the building safe in any case and under any action, as some adaptation work seems to claim. The point is that the knowledge of a historic building will never allow the confidence one can get in the computation of a new structure, but it is the best way to identify rational decisions. Italian guidelines for the evaluation of the seismic risk on historic buildings (DPCM 2011) are a very advanced document, and they suggest progressive levels of confidence on the basis of the quality of data the designer can use. The relevance of investigation should never be underestimated (Saisi, Cantini, Binda 2011).

Any evaluation on preventive improvement turns into a sort of mass appraisal of vulnerability , risks and resources. That's why geographic information systems are a powerful tool for the implementation of effective policies. A good example is Italian Risk Map ("Carta del Rischio"), inspired by the pioneering proposals by Giovanni Urbani, the ancestor of "conservazione programmata". This information system aims at surveying and illustrating the vulnerability of individual monuments and historical buildings, and at filing information on their state of repair (Cacace, Fiorani 2014). This gives precious support to decision making, as the system dialogues with the maps of seismic actions and other major hazards (flooding, air pollution, etc.).

Relevant researches in this direction are testing simplified indexes for the seismic assessment of masonry buildings (Lourenco et al. 2013), as well as exploring local failure modes (Fava et al. 2015). As the assessment of the global behavior of a building or a complex aggregate is not always simple nor reliable, the reduction of local fragility is often the more feasible strategy, and the one that matches better with a maintenance-based policy.

4 CONCLUSIONS

This rapid review had the purpose of showing how far the adoption of a long term vision and the understanding of conservation as a continuous process could change everyday behavior of the actors in heritage field, especially those who have responsibilities with structures.

The findings can be summarized in some final bullets:

- long term vision implies an approach oriented to take into account the quality of the outputs of any activity, optimizing the timely use of resources and the consistency of required actions, as well as choosing the best direct or indirect strategy;
- historic buildings should be dealt with as complex systems, whose fragility is both global and local: the care for local vulnerability requires special attitudes, which should be embodied in the procedures for safety assessment;
- the effectiveness of regular maintenance is relevant also to global structural health of buildings, and this holds also for inspections and monitoring

systems, given the importance that knowledge takes in assessment procedures;
- "knowledge" is a challenging term, as it encompasses gathering technical data, but also understanding the historic singularity of existing buildings, with the curious attitude typical of archaeologists;
- a good state of repair is the best form of preparedness to risk, but the implementation of a management (and maintenance) system gives benefits also in terms of available procedures, skills and resources;
- among structural risks, seismic risk for masonry structures has been investigated by huge literature, leading to sound knowledge and developing retrofitting techniques, but the risk still exists of heavy adaptation works carried out without any attention to deontological principles of conservation;
- for the nature of seismic risk, seismic assessment should be widely extended to historic settings, implementing simplified indexes and tools to identify local failure modes;
- Italian guidelines (DPCM 2011) are an interesting example as they suggest progressive levels of confidence on the basis of the reliability of the available knowledge;
- geographical information tools could support such mass appraisal of vulnerability and related decision making;
- policies and building codes should make mandatory the reduction of local vulnerability as any renovation or maintenance work is carried out.

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