American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-7, Issue-11, pp-01-13
www.ajer.org
Research Paper Open Access

Management of conservation status of the minor architectural heritage.A comparison between the faster tools of analysis.

Domenico Colapietro*-**, Fabio Fatiguso*, Costanza Semeraro, Marco Pinto**, Pasquale Calisi**

**DICATECh, Politecnico di Bari, Bari, Italy*
***Studio COLAPIETRO: Ingegneria Strutturale & Consulting, Bari, Italy*
Corresponding Author: Domenico Colapietro

ABSTRACT : *An ever increasing portion of building interventions in Italy is increasingly concerned, beyond the monumental singularities, the historical patrimony so-colled minor or ordinary, after a greater importance of the historical-architectural value of these buildings, of the importance of their valorization, such to be more sensitive to the theme of their conservation.Recovering an historical building certainly means to get back in possession of what has been lost, the reacquisition of a disappeared condition, and is a usually complex action that has to combine the respect of the existing one (materials, shapes, meanings, history) with the needs of current users, taking into account the available resources and capabilities, seeking a balance between the different requests with the contribution of different disciplines. This operation is possible only through the use of pre-analysis methodologies able to immediately assess the state of conservation and risk of loss of the building organism being recovered.Thereby it is possible to identify an emergency staircase between the individual architectures which direct the subsequent detailed evaluations and avoid unnecessary deployment of resources, ensuring the maintenance of large-scale urban buildings. The present study aims to comparetwo tools able to ensure the achievement of these intentions, comprising analogies and divergences of their conceptual modus operandi.*

KEYWORDS: *Building Information, Conservation Status Assessment, Deterioration, Historical Buildings, Local and Global Analysis, Vulnerability.*

Date Of Submission:02-11-2018 Date Of Acceptance: 16-11-2018

I. INTRODUCTION

During the last decades the concept of recovery as a complex of interventions aimed at preserving the historical-artistic interest and transmitting the cultural values of the architectural heritage so-called minor has taken on great interest.

Retrieving this new multitude of architectures means giving them new importance and recovering a previously lost condition, through a set of interventions aimed at their rehabilitation, reconstruction, preservation and better use.

The discipline of recovery identifies the new needs of the users, interprets the delicate relationship between physical form and functional needs, and adapts the building organism to the latter, leaving the pre-existing image legible and recognizable. The interventions are aimed at maintaining the values of historical-artistic interest and the formal and structural unity.

Managing the numerous traditional architectures, object of recovery, requires seismic prevention and maintenance strategies.

Therefore, it is essential to use pre-analysis methodologies that can immediately evaluate the state of conservation and the risk of loss of the building organism being recovered. In this way it is possible to identify an emergency scale between the individual architectures that directs the subsequent evaluations of detail and avoid unnecessary deployment of resources, performing appropriate recovery interventions,out according to a correct temporal scan of emergency are made. These methods focus on the knowledge of the original conditions, of the construction techniques of the time, of the alterations undergone, of the ensuing phenomena and of the work at present.

Thanks to the use of quick methods, it is therefore possible to carry out a preliminary but very reliable evaluation of the remaining performance qualities of the building organism examined without the need to necessarily resort to an evaluative burden that could be disproportionate to the aims of the project and of the interventions.

II. METODOLOGIES

All' Within the process of structural recovery, the cognitive survey takes on fundamental importance.

The non-use of quick evaluative methods means that the cognitive process is limited to the use of diagnostic tests to identify the morphology of the wall face, of the characteristics of the texture of the masonry and of the presence of interventions, deterioration and ruins that could not be visible. In this way, information on the wall face is obtained, but there are no results with regard to its performance qualities.

But all this is not enough. Going over the simply diagnostic operative execution, ratified methodologically by norm, it is possible to understand the performance quality and the constructive capacity of the single technological elements that settle the structure. It's how technically accomplished by two instruments for the evaluation of the state of construction conservation of the wall artefact. the IQM and the ANVIV protocol.

The first method arises from the awareness of the absence of a good knowledge about the different behaviour of each different type of masonries for their morphology and constructional techniques. This incompetence has highlighted the need for a methodology capable of guaranteeing their mechanical analysis even by non-expert technicians in the field. The evaluation method of the performance qualities makes use of the masonry quality index (IQM). This value is the result of the judgment on the observance of the parameters of the rule of art, that is of those constructional devices that guarantee the masonry monolithicity, compactness and good behaviour. A scheduling form (Fig.1), containing the description of the partial, absent or total compliance with these parameters, makes it possible to express a judgment on the constructional criteria with consequent assignment of a score.


SOLUZIONE MURARIA

QUALITA' MURARIA

QUALITÀ DELLA MALTA (MA.) — R / PR / NR

PRESENZA DI DIATONI (P.D.) — R / PR / NR

FORMA DEGLI ELEMENTI RESISTENTI (F.EL.) — R / PR / NR

DIMENSIONE DEGLI ELEMENTI RESISTENTI (D.EL.) — R / PR / NR

SFALSAMENTO FRA I GIUNTI VERTICALI (S.G.) — R / PR / NR

PRESENZA DI FILARI ORIZZONTALI (OR.) — R / PR / NR

RESISTENZA DEGLI ELEMENTI RESISTENTI (RE.EL.) — R / PR / NR

Fig.1. Schedule form on compliance with the parameters of the art rule

Through the equations (1), (2) and (3), it is possible to obtain the masonry quality index for vertical IQM_v, out of the plane IQM_{FP} and in the plane IQM_{NP} stresses.
$IQM_v = REEL_V$ x $(OR_v + PD_v + FEL_v + SG_v + DEL_v + MA_v)$ (1);
$IQM_{FP} = REEL_{FP}$ x $(OR_{FP} + PD_{FP} + FEL_{FP} + SG_{FP} + DEL_{FP} + MA_{FP})$ (2);
$IQM_{FN} = REEL_{FN}$ x $(OR_{FN} + PD_{FN} + FEL_{FN} + SG_{FN} + DEL_{FN} + MA_{FN})$ (3);

From the value obtained from the three indices, one of the classes A, B or C is assigned to the masonry. This classification gives information about the behaviour in relation to the direction of the applied force. Conventionally, a different colour is assigned to each class (Fig.2) in order to identify the performance qualities of the building system. Thanks to the use of this methodology, even non-expert masonry technicians are able to evaluate the performance qualities and, consequently, the mechanical parameters necessary for security checks for the existing buildingsenshrinedby norm for the existing buildings.

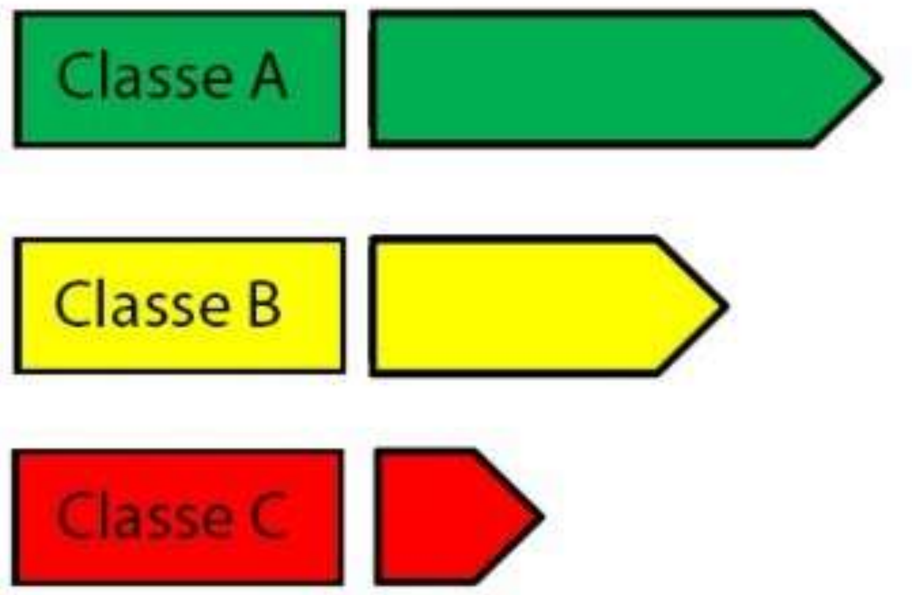

Fig.2. Classification indicating the masonry quality

The methodology that makes use of the IQM calculation takes into account the only devices with which the wall face was originally built. The ANVIV protocol is an evaluation methodology that implements the evaluative parameters taken into consideration with this method and introduces new ones related to the way the masonry is connected to the brace walls, to what its inner morphology is, to which the previous consolidation interventions are and to the presence of deterioration pathologies.

The state of constructional conservation is not analyzed for the only wall face as it would not give results close to the real ones since the constructional characteristics of the entire structure are the result of the correlation between three main technological sub-systems in which it is disarticulated: vertical load-bearing closing systems, horizontal load-bearing closing systems and vertical connection systems.

Only after the identification of the structure, the evaluation of the technological-constructional characteristics and of the possible presence of deterioration is carried out through the calculation of the constructional capacity index (ICC) which is obtained, indeed, through the equation (4) which takes into account the technological quality index (IQT) and the pathological deterioration index (IDP).

ICCi* = f (IDPi*, QTi*) (4)

The scheduling form, useful for obtaining the first of these last two indices, contains parameters relating to the perspective, transversal constructional quality of the connections between the wall facades, and to the presence of previous consolidation interventions. (Fig.3)

Fig.3.Schedule forms on the perspective, transversal constructional quality of the connections between walls, and on the presence of previous consolidation interventions

The judgment regarding the presence of deterioration pathologies is possible through the compilation form which takes into account their gravity, extent and severity (Fig.4).

Fig.4. Schedule form on the presence of degradation diseases

From the scheduling modules it is clear how the second method takes into consideration many more elements. Indeed, the parameters of the rule of art used to obtain the IQM are present in the only section related to the perspective quality.

Thanks to the use of the ANVIV Protocol it is possible to assign some constructional capacity classes A, B, C, D, and E (Fig.5) which give important information about the priorities of interventions and of analytical evaluations of detail, so as to optimize time and to target resources correctly.

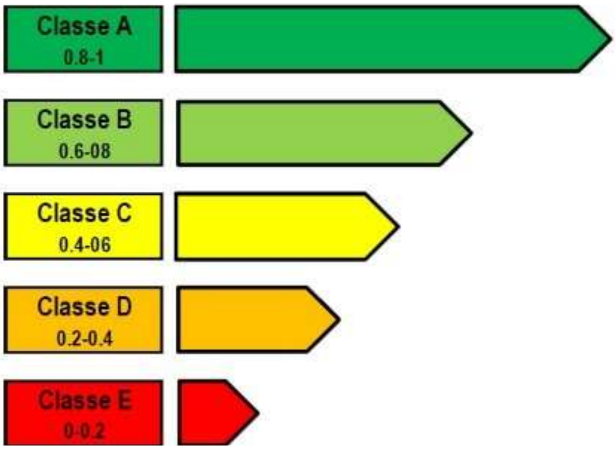

Fig.5. Classification indicating the constructive capacity

III. THE CASE STUDY

The two methods previously illustrated have been applied to Palazzo Delle Mura. This is an eighteenth-century building located in the historic centre of Palo del Colle whose main façade overlooks Piazza Santa Croce, on which the ChiesaMatrice, the Church of Purgatorio and the Palazzo del Principe, that is the most important monuments of the town representing the symbols of the spiritual and temporal power, stand out. Around this complex of buildings, small peasant houses arranged along very narrow streets were built around the nineteenth century.

Palazzo Delle Mura with a compact and imposing structure stands for 14 meters in height on the square and occupies a volume of about 10400 square meters. On the first two levels the façade has rough stone ashlars with a fairly regular shape which contrast with those on the top floor which, on the contrary, are much more irregular. The last level, moreover, has two arches that decorate and streamline the structure.

The building faces the north-east side of the square for 20 meters and is bordered by Via Torquato Tasso on the east and by other buildings and the Church of Purgatory on the west side. The only visible façades are the main and the rear one that overlooks an inner courtyard that cannot be reached from Via CesareCantù.

The building consists of 47 rooms and four levels, three above ground and one underground (Figure 6).

Fig.6. Facade of the Palazzo delle Mura

Its construction dates back to the eighteenth century, but it has undergone many changes during the second half of the twentieth century because of the replacement of the concrete and masonry, and wooden type ceilings.

The different floors are connected to each other by a single stairwell without a roof which allows the access to the first level (Fig.7).

Fig.7. Stairwell

The second floor can only be reached through a ladder placed in a room accessible by an outdoor terrace.

The basement (Fig.8), made up of 10 rooms, is made almost entirely of vertical load-bearing sub-systems in limestone with rough ashlars and sometimes overhanging rock awash banks. Only two are the rooms partially made up of tuff walls and concrete and masonry ceilings.

Fig.8. Basement

A vault of tuffaceous stone (Fig.9) resting on limestone ashlars and rock awash is present.

Fig.9. Vault of tuffaceous stone

The ground floor (Fig.10), made up of 12 rooms, has vertical and horizontal sub-systems that are almost entirely made of limestone (Fig.11) except for part of a single cross vault made of tuff.

Fig.10. Ground floor

Fig.11. Vault of limestone

At the entrance of the structure, the vertical load-bearing subsystems of the ground floor present some interventions of regeneration of the nucleus, while the horizontal ones show some interventions with metal chains. Some openings have also been walled with tuff ashlars.

The first floor (Fig.12), with 16 rooms, presents almost entirely limestone masonry except for the rooms containing the ladder. The ceilings are all concrete and masonry except for a semi-spherical vault (Fig.13) and 3 tuff cloister vaults.

Fig.12. First floor

Fig.13. Semi-spherical vault of tuffaceous stone

Part of the walls below the vaulted systems are made of the same material. The last level (Fig.14), with 9 rooms, presents mainly vertical load-bearing sub-systems in limestone and wooden ceilings (Fig.15).

Fig.14. Secondfloor

Fig.15. Wooden ceilings

Only at the entrance of the inner courtyard in the basement and in the corresponding area on the ground floor there is a rising damp. It is a phenomenon that, however, appears to be of irrelevant importance and in slight progression.

The rest of the building does not show any deterioration pathology, but there is a widespread problem generated by an intervention of joint sealing with cement-based mortar of absolute invasiveness, poor reversibility and only cortical efficacy.

IV. RESULTS

The two evaluation methods applied to the case study are related one to the performance qualities and the other to the constructional capacities. With the first method, only 40 masonries, on which endoscopic investigations were carried out, have been analyzed, with the second method, on the other hand, also the ceilings were examined.

Starting from the compilation of the scheduling forms regarding the judgment on the compliance with the parameters of the rule of art, the technical-constructional characteristics and the deterioration of the sub-systems, both the masonry quality index (IQM) and the constructional capacity index (ICC), and the consequent classes of performance of the masonries and all the ceil

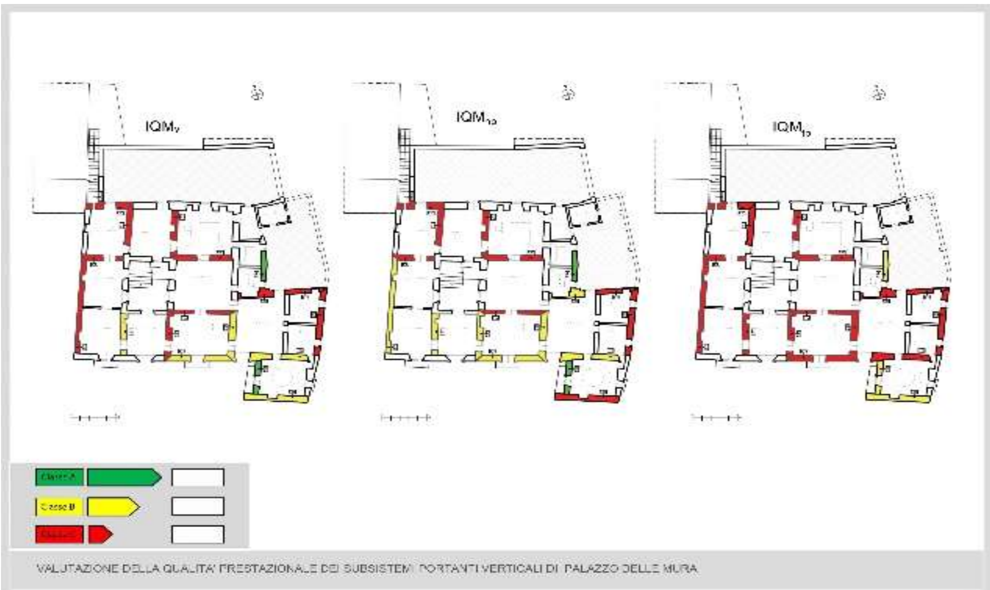

Fig.16. Classification of analyzed masonries using the masonry quality indexIQM

Fig.17. Classification of analyzed masonries using the constructive capacity index ICC

The comparison shows that the results obtained with the two methods are not so different. A high IQM value, that is a class A, coincides with a constructional class of type A or B.

To a low IQM value, that is a class C, corresponds a constructional index of type D or type E.

Off the 40 masonry subject to vertical action, the behavior for the 25% is average, for the 27.5% good and for the 47.5% bad.

Under off-plan action, 35% of vertical load-bearing subsystems has a performance class of type B, while the remaining 65% of type C.

The classification of masonries subject to coplanar actions, instead, places 27.5% of these in a good category, 35% in an average and 37.5% in a poor one.

The application of the ANVIV Protocol, on the other hand, shows that only 15% has a sufficiently good constructional capacity (Class B), while the remaining 85% has a medium constructional capacity (Class C).

Comparing the results obtained with the first and the second method, it is clear that, considering the masonry examined, 17.5% has a good performance quality, 32.5% an average and 50% a poor one, while the constructional capacity is good enough for the 15% and average for the 85%.

It is easy to notice that the first methodology has assessed many masonries of poor quality, while the second one has not assigned to any masonry a class below the average.

This difference is due to the fact that some masonry sub-systems present consolidation interventions which, however, are not considered for the calculation of the IQM.

By comparing the results obtained with both methods (Fig.18), we can see that some masonry subsystems such as E24 and E29 show essential differences.

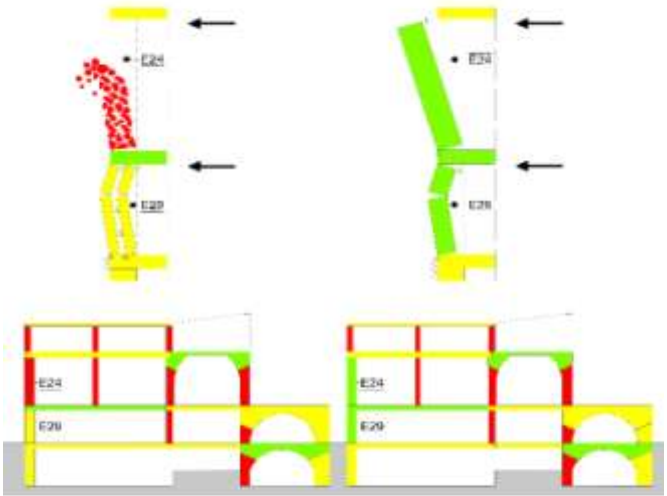

Fig.18. Comparison of the results obtained with the two methods on some masonry sub-systems

Considering an out-of-focus solicitation, with the first methodology, one of the two is of medium quality and is divided into parts, the other is of poor quality and disintegrates. Considering the results deriving from the application of the ANVIV Protocol, on the other hand, they are both of good quality and therefore have a monolithic behavior and do not tend to split or disintegrate.

From this comparison it is useful to deduce the importance of the consideration of different factors for the performance evaluation. Not only the original constructional characteristics of the masonry should be taken into account, but also the presence of transformations undergone because of human actions or natural obsolescence. Only in this way it is possible to obtain results in terms of performance that are as close as possible to the real condition of the building organism that is going to be analyzed.

Moreover, the results established by the ANVIV protocol, unlike the masonry quality index, for about 67% of the wall solutions are much closer to what can be achieved by performing detailed analytical assessments of static seismic vulnerability, through the elaboration of a finite element mathematical model (Fig.19).

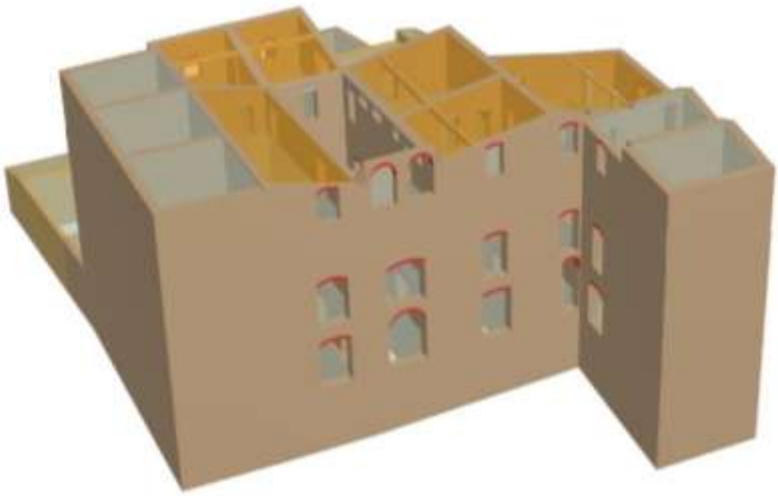

Fig.19. Mathematical model of finite elements

V. CONCLUSION

It is easy to understand how the knowledge of the constructional conservation state of the structure is a fundamental step within the process of recovery because it is only through this that it is possible to guarantee not only the effectiveness of the intervention, but also a correct use of the

resources and time optimization.

Making detailed diagnostic investigations on the entire structure may not be an appropriate choice as it would overshoot the costs required by the client or in any case it would head for a disproportionate burden with respect to the object of the project and of the intervention.

The best solution is to understand, in the shortest possible time and with the least waste of resources, what the remaining performance qualities of the different sub-systems of the structure are, so that further investigations can be avoided in some cases or deepen in others.

The knowledge acquired through the methods described, even if rapid,

is able to give information about the state of physical preservation of the building organism and to understand the risk of assessment and reduction of losses of historic buildings,

controlling, by means of appropriate choices, waste of money and time.

Therefore, by optimizing the cognitive process, it is possible to correctly evaluate the priority and destination of the resources and, avoiding ineffective and invasive interventions, to guarantee the return of the original image, the preservation of the historical-architectural interest and the conservation of the identity of the structure.

REFERENCES

[1]. D. Colapietro et al. (2015) "Analysis of cooperative interpretation of constructive and degradation informations for the assessment of the state of physical preservation of traditional architectures in prevalent vertical development. The ANVIV protocol". RivistaTeMA: Tempo, Materia, Architettura. Vol. 1, No 2 (2015) Towards 2020.

[2]. A. Borri, A. De Maria, Indice di qualità muraria Applicazioni nell'ambito delle NTC 2008, (Perugia, Italy, Dipartimento di Ingegneria Civile ed Ambientale, Università degli Studi di Perugia, Servizio Controllo Costruzioni e Protezione Civile, Provincia di Perugia).

[3]. A. Borri, A. De Maria, Indice di qualità muraria (IQM) e correlazione con le caratteristiche meccaniche, (RELIUS, Italy, Università degli Studi di Perugia, 2015).
[4]. A. Borri, Comportamento meccanico delle costruzioni in muratura. Qualità muraria e livelli di conoscenza. (Perugia, Italy, Facoltà di Ingegneria, Università degli Studi di Perugia).
[5]. L. Binda, A. Saisi, Knowledge of the building, on site investigationand connected problems, (Milan, Italy, DIS, Politecnico di Milano, 2015).
[6]. L.Binda, G. Cardani, A. Saisi, A classification of structures and masonries for the adequate choice of repair, (Milano, Italy, DIS, Politecnico di Milano).
[7]. L. Binda, A. Saisi, Application of NDTs to the diagnosis of Historic Structures, (Milano, Italy, DIS, Politecnico di Milano, 2009).

Domenico Colapietro. "Management of conservation status of the minor architectural heritage.A comparison between the faster tools of analysis." American Journal of Engineering Research (AJER), vol. 7, no. 11, 2018, pp. 01-13