Advanced Materials Research Vols. 133-134 (2010) pp 485-489

doi:10.4028/www.scientific.net/AMR.133-134.485

Masonry Analysis Interpretation and Data Archive System

ADORNI Elisa[1, a] and BLASI Carlo[2,b]

[1,2]Department of Civil-Environmental Engineering and Architecture,
University of Parma, Parma, Italy

[a]adornielisa@hotmail.it, [b]carlo.blasi@unipr.it

Abstract Diagnostic analysis, required to characterize materials and mechanical parameters of ancient masonry, needs a systematic collection and a careful reading of data results, as well as the cross-check of results of the different samples collected.

This work assumes that diagnostic is part of the knowledge phase of existing buildings: knowledge level is fundamental to evaluate the state of conservation, as prescribed also in italian Technical Standards for Construction (2008).

This paper describe some characteristics of a database system, M.A.I.D.A - Masonry Analysis Interpretation and Data Archive, performed to contain diagnostic analysis results of traditional materials and constituted by interactive analysis cards. Cards nomenclature and method follow UNI Normal rules for the construction materials: stones, bricks, mortars.

Some tests on M.A.I.D.A system were carried out in a cooperation project between University of Parma and University of Rome 'La Sapienza'. The project comprehends analysis of the Carolingian masonry and mortars from some buildings in Rome: SS. Quattro Coronati ecclesiastic complex, S. Francesca Romana Church and a Carolingian part of the Aurelian Walls in Rome.

In order to enforce the data archives and to share the results M.A.I.D.A system will be put in a internet server.

Keywords: Database, diagnosis, traditional material, masonry, knowledge level

Introduction

Professionals involved in the memory preservation of the monument are many, both in architectural history, in conservation and consolidation of monuments.

A building is a set of stratifications and changes occurred over the years; for this reason, its study includes many disciplines: the study of the sources, the geometric survey, the thematic mapping; each element gives essential information about the monument. Surely all this information, to be accessible and usable in the practice of monuments consolidation and preservation, must be collected and systematized (Liserre and Bartolomucci 2009; Musso 2006).

The questions are: all information must be archived? Of course not and then what? What is the critical assessment to use?

The most relevant answer could be the following:

All the information and data necessary and sufficient for the historical knowledge of the building and the conservation of the monument, so that could be possible its preservation in coherence with the ethics of restoration.

An archive, that can be consulted and sharable, is of course an important tool in the monuments study, all the more so for structural interventions. Access to existing documentation relating to the conservation history of a monument allows the processing of a less invasive project, that respects the *principle of minimum intervention*. Conservation and consolidation projects are closely connected to the critical analysis of architectural materials, damages, previous interventions, and the diagnostic is an essential contribution to read them.

The monument, on which professionals currently work, is the result of different project choices and modification produced, during the time, by several civilizations. It is, at the same time, "history" and "material" and any intervention must be tackled taking into account this double aspect (Torraca 1988).

The material, that constituted a monument, is representative of the area and the historical quarries, that, over the time, supplied lime and stone, sand and clay. A lot of them have been exhausted, but if you want to preserve even a simple "wall" should be able to know its "material nature".

In a database, who works on the monument (historians, engineers, architects, restorers, technicians, etc.) can find information about materials and their mechanical characteristics, about executive methods and fundamental geo-referencing of samples; this is the purpose that the working group has set. It is quite clear the importance of a critical data-gathering, but at the same time is important the organization of the sharing system; the latter is, indeed, the fundamental aspect for any authentic scientific work. A database to insert geological map references, building characteristics and physical-chemical analysis of materials is therefore, despite its relative simplicity, an absolutely essential tool for those who work for the monuments safeguard.

Project

Up to now, existent informatics archives have been mostly applied to individual specific cases (Santana-Quintero and Addison 2007; UNESCO 2007; World Monuments Fund 2007). Nationwide, the few attempts of research data sharing, conducted on the historical heritage, are limited to the creation of "object-image-description" cards (Capponi 2001; Bartolomucci 2004). These archives do not contain fields to enter results of diagnostic studies on materials (mechanical and physico-chemical analysis).

Well as historical and conservative valuations, diagnostics is an important instrument for the assessment of seismic risk of existing buildings. This work assumes that diagnostic is part of the knowledge phase of buildings: knowledge level is fundamental to evaluate the state of conservation, as prescribed also in italian Technical Standards for Construction (2008); where the confidence factor, which determines the importance of the intervention, is closely linked to the knowledge level of the building.

Obviously, is not possible plan for all buildings a widespread and invasive diagnostics campaign. Therefore, italian Technical Standards for Construction (2008) prescribes that the identification of mechanical characteristics of masonry and physical-chemical properties of materials can be obtained by analogy with similar walls and similar materials (whereas of course the phenomenon of degradation).

At present, the results of studies and diagnostic tests are reported in technical papers and limited to certain special cases. To simplify the process of comparison and identification of parameters needed for seismic analysis, the same Technical Standards for Construction (2008) wants to establish a permanent database containing: a) almanacs of various masonry typologies, used in different geographical areas, b) tables with reference values of mechanical properties, derived from experiments on specific cases; c) tables with materials proprieties: mortars, bricks, stones, characterized with *in situ* other laboratory tests.

On the basis of these requirements, this paper describe some characteristics of a database system, M.A.I.D.A - Masonry Analysis Interpretation and Data Archive, constituted by interactive cards and folders, performed to contain the results of traditional materials diagnostic analysis.

Some peculiar characteristics of the database are following reported:

- Buildings informations cards: photos, plans, construction typologies, etc.;
- Boxes to insert the ancient masonry characteristics of studied buildings: photos, location, orientation, structural function, materials, samples collected, etc. (Fig. 1);
- Creation of a sample card for each collected material linked to the related masonry card (Fig. 2);
- Creation of cards with mechanical characteristics of materials and masonry, linked to the masonry folders.
- Possibility to generate samples association and cross-checks of material characteristics in order to compare peculiar similarities in the recipe, find historical connection, hypothesize other confirm

constructive dating, etc., not only among samples of the same building, but also with all samples present in the database (this is useful when the study is focused on a masonry typology presents in several buildings);

- Creation of personal reports with analysis data results;
- Through a shared server, the archive can be shared and implemented by several operators.

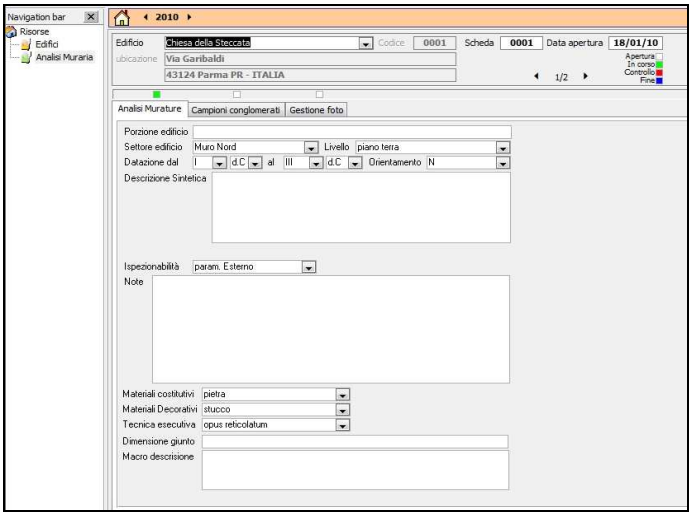

Figure 1: M.A.I.D.A. graphics interface. Part of a masonry card liked to the building folder

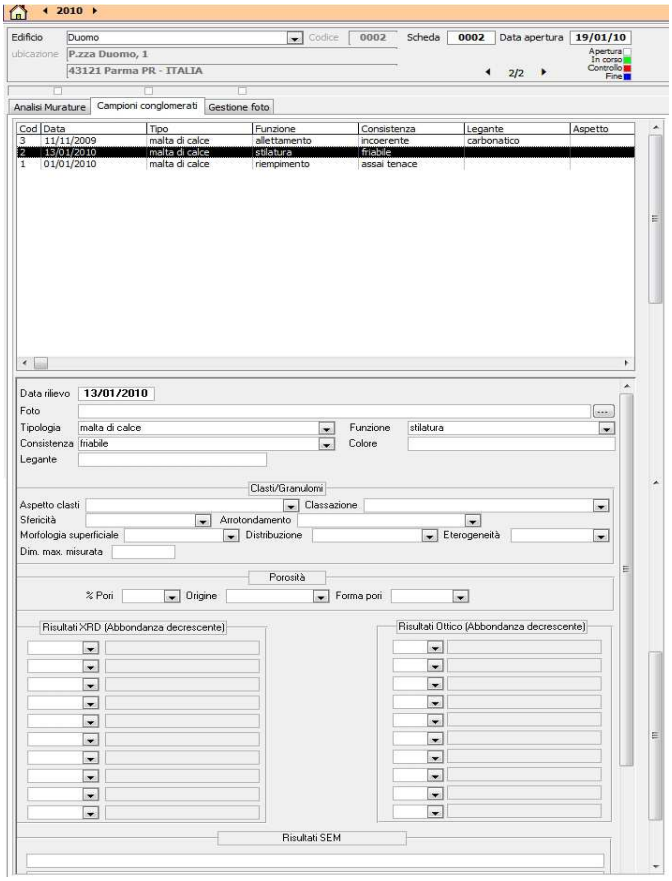

Figure 2: M.A.I.D.A. graphics interface. Example of a sample schedule. The encoding is automatic (a number for the sample and a code letter for the building). Morphological, mineralogical, chemical and physical description could be enter in fields

Data computerization allows to share information from case-studies in a organized and easily comparable and integrable way, in particular, this is possible through the adoption of a clear

terminology in common with the different specialized fields involved in the preservation and consolidation of the architectural heritage, such as: engineers, architects, chemists, geologists, restorer, technicians, etc.

According to this, the database adopts the nomenclature of italian UNI Normal rules for construction materials: stones, bricks, mortars (1980; 1981; 1982; 1983; 1984).

Application Case

Some tests are going to be performed on M.A.I.D.A - Masonry Analysis Interpretation and Data Archive - system in a cooperation project between University of Parma and University of Rome 'La Sapienza'. The project comprehends the analysis of the Carolingian masonry and mortars from some buildings in Rome: SS. Quattro Coronati ecclesiastic complex, S. Francesca Romana Church and the Carolingian part of the Aurelian Walls in Rome.

The first step concerned, with the collaboration of Prof. Lia Bertelli (University 'La Sapienza' of Rome), the analysis of the building and the definition of the essential parameters for the description of the ancient masonry (Fig. 1). After that, have been defined data collection sheets for materials samples (Fig. 2). For the mineralogical and petrographical characterisation, the nomenclature of italian UNI Normal rules for construction materials was adopted (1980; 1981; 1982; 1983; 1984) together with rock-forming minerals symbols suggested by Kretz (1983).

Some fields are guided through multiple solutions, but there are many other free areas to enter notes, descriptions, features, identified during diagnostic analysis. Both possibilities are important: the first allows to search using keywords, set to a shared vocabulary; the second allows to insert details and peculiarity may not always having reference to a predetermined language. The next step is the definition of fundamental mechanical parameters of the masonry to insert in the walls analysis sheets.

Conclusion

Diagnostic is part of the knowledge phase of the monument, it gives essential information about its alterations and transformation during the time. Diagnostic regards historical and conservative valuations and mainly it is also an important instrument for the assessment of seismic risk of existing buildings.

Surely all these informations, to be practically accessible and usable must be collected and systematized in an archive system. An archive should help to make a diagnosis clear and more evident, and also improve the sharing between professionals.

A database system helps to preserve the historical knowledge of building techniques and the characteristics of ancient materials, but can also facilitate the comparison between similar cases useful for the characterization of the mechanical parameters of the masonry, thus limiting invasive diagnostic interventions on the monument, as prescribed also in italian Technical Standards for Construction (2008).

The database M.A.I.D.A., described in this work, requires further experimentations to improve the entering and linking of data, and especially to implement the masonry mechanical parameters area.

Support tool for expert and moreover, it should help in sharing knowledge among all professionals and allows the processing of a less invasive project, that respects the principle of *minimum intervention.*

Acknowledgment

A special thanks to Roberto Arisi (*Arisingtech*, Parma, Italy) for the Database system program support.

References

[1] Bartolomucci, C (2004). "Santa Maria di Collemaggio: interpretazione critica e problemi di conservazione." Palombi, Roma.
[2] Capponi, G et al. (2001). "Un'applicazione nella mappatura dei materiali costitutivi e dello stato di degrado della Torre di Pisa," *in "Usi e consumi dell'informazione geografica", proceedings 3^ conferenza*, MondoGis, Roma, 229-236.
[3] D.M. 14/01/2008, Ministero italiano delle Infrastrutture, G.U. n. 47, 26/2/2009.
[4] Kretz, R (1983). "Symbols for rock-forming minerals." American Mineralogist, 68, 277-279.
[5] Liserre, F R, Bartolomucci C (2009). "*Tecnologie per la conoscenza della fabbrica,*" in Fiorani, D (2009) "*Restauro e tecnologie in architettura.*" Carocci, Roma, 97-105.
[6] Musso, S F (2006). "*Recupero e restauro degli edifici storici. Guida pratica al rilievo e alla diagnostica.*" EPC libri, Roma.
[7] Raccomandazioni NORMAL 10/82 (1982). "*Descrizione petrografica dei materiali lapidei naturali*." ed. CNR-ICR, Roma.
[8] Raccomandazioni NORMAL 12/83 (1983) "*Aggregati artificiali di clasti e matrice legante non argillosa: schema di descrizione*." ed. CNR-ICR, Roma.
[9] Raccomandazioni NORMAL 15/84 (1984). "*Manufatti e aggregati a matrice argillosa: schema di descrizione*." ed. CNR-ICR, Roma.
[10] Raccomandazioni NORMAL 16/84 (1984). "*Caratterizzazione dei materiali lapidei in opera e loro stato di conservazione: sequenza analitica*." ed. CNR-ICR, Roma.
[11] Raccomandazioni NORMAL 2/80 (1980). "*Archiviazione materiali lapidei: schema di scheda*." ed. CNR-ICR, Roma.
[12] Raccomandazioni NORMAL 8/81 (1981). "*Esame delle caratteristiche morfologiche al* Microscopio Elettronico a Scansione (SEM)." ed. CNR-ICR, Roma.
[13] Santana-Quintero, M, and Addison, A C (2007). Digital tools for heritage information management and protection: the need of training. [Online]. Available: https://lirias.kuleuven.be/bitstream/.../1/07VSMM_santanaaddison.pdf
[14] Torraca, G (1988). "Il progetto di restauro tra artigianato e industria. Lo studio scientifico e la documentazione," in Biscontin, G, Vassallo, E, Volpin, S (1988). "*Le scienze, le istituzioni, gli operatori alla soglia degli anni '90*," proceedings: Convegno di Studi di Bressanone, Libreria Progetto, Padova, 205-217.
[15] UNESCO's World Heritage Centre (2007). Development of a World Heritage Information Management capacity in the Arab States. [Online]. Available: http://whc.unesco.org/en/activities/58/
[16] World Monuments Fund (2007). Getty Conservation Institute Iraq Cultural Heritage Conservation Initiative. [Online]. Available: http://www.getty.edu/conservation/field_projects/iraq/index.html - http://www.wmf.org/iraq.html