VIII Congresso Nazionale di Archeometria
Scienze e Beni Culturali: stato dell'arte e prospettive
Bologna 5 - 7 Febbraio 2014

BUILDING MATERIALS AND DEGRADATION PHENOMENA OF THE FINALE EMILIA TOWN HALL (MODENA): A STUDY FOR THE RESTORATION PROJECT AFTER THE 2012 EARTHQUAKE

S. Lugli[1], M. Caroselli[1], S. Marchetti Dori[1], V. Vandelli[2], G. Marzani[2], R. Segattini[3], C. Bianchi[3] e G. Gerrini[4]

[1] Dipartimento di Scienze Chimiche e Geologiche, Università di Modena e Reggio Emilia, stefano.lugli@unimore.
[2] Studio Progettisti Associati, Sassuolo, Modena
[3] Fondo Ambiente Italiano
[4] Comune di Finale Emilia

The Town Hall of Finale Emilia (18th century; Modena) is one of the 1600 historical buildings seriously damaged by the seismic crisis that affected the Emilia region of Northern Italy in May 2012.
FAI, Fondo Ambiente Italiano (Italian National Trust) selected this important building for a complex restoration and structural strengthening project. A nationwide fundraising campaign was immediately launched to bring back to life the symbol of the community so badly struck by the earthquake. The restoration project is now in its executive phase under the scientific supervision of Direzione Regionale per i Beni Culturali e Paesaggistici.
Among many other diagnostic tool that have been applied to elaborate the restoration project, detailed surveys and petrographic analyses were performed to characterize the ornamental stones and their alteration phenomena and the historic mortars and plasters [Lugli et al. 2009, Lugli et al. 2010]. In particular, the study of more than 40 samples provided fundamental information to distinguish different building phases and to formulate the composition of compatible repair mortars.

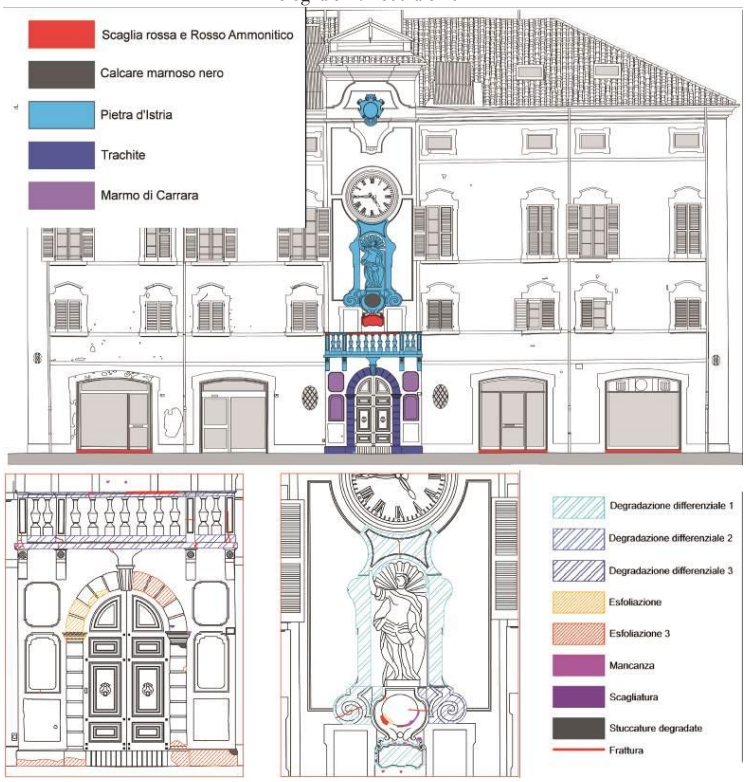

Fig. 1 Map of the ornamental stones and map of selected alteration phenomena in the facade of the Town Hall.

Six different types of natural stones were identified in the facade of the building: pietra d'Istria from Croatia, Rosso Ammonitico and Scaglia Rossa from the Verona area, trachyte from the Euganei Hills (Padua), Carrara marble from the Apuane Alps and a marly limestone from the Northern Apennines. All these stones were typically imported in the Modena area since ancient times (Lugli, 2010). The alteration phenomena of the ornamental stones are mostly related to various degree of black crust, differential degradation, exfoliation, granular disaggregation, weathering, surficial deposits, biological attack, soluble salts efflorescence, rust staining and fractures (Fig. 1).

The balcony shows the most severe alteration phenomena highly enhanced by the structural damage caused of the earthquake.

Three types of binder were recognized in mortars and plasters: 1) lime with variable hydraulic properties produced by burning impure limestone cobbles (Fig 2a); 2) gypsum, used for decoration plasters, in some cases without aggregate; and 3) cement, which characterizes the later additions of the building.

The composition of the aggregate mixed to the binders allows to distinguish the provenance of the sand [Lugli et al. 2007], a useful tool for the reconstruction of construction phases [Lugli et al. 2013]. The Panaro River sand was identified in mortars and plasters from the most ancient parts of the building (lime and gypsum, Fig 2a), whereas a provenance from the Secchia River characterizes later plaster addition (Fig. 2b). In more recent years, renovation works were supplied with raw materials from different sources: the Po River sand (recognizable by higher percentage of quartz and feldspar (Fig 2c) and the Veneto area sands containing different types of Mesozoic limestone fragments (Fig. 2d).

The stratigraphy, composition and textural parameters of mortars and plasters clearly distinguish all the building phases of the palace. The decorations of the most prestigious rooms at the main floor underwent many changes in time. The ground floor show two different ancient mortars and several modern cement additions. The external masonry are characterized by mortars with *cocciopesto* and several cement plaster additions.

The most important alteration phenomena affect the ground floor mortars with secondary gypsum formation and binder dissolution phenomena followed by of secondary calcite precipitation within pores.

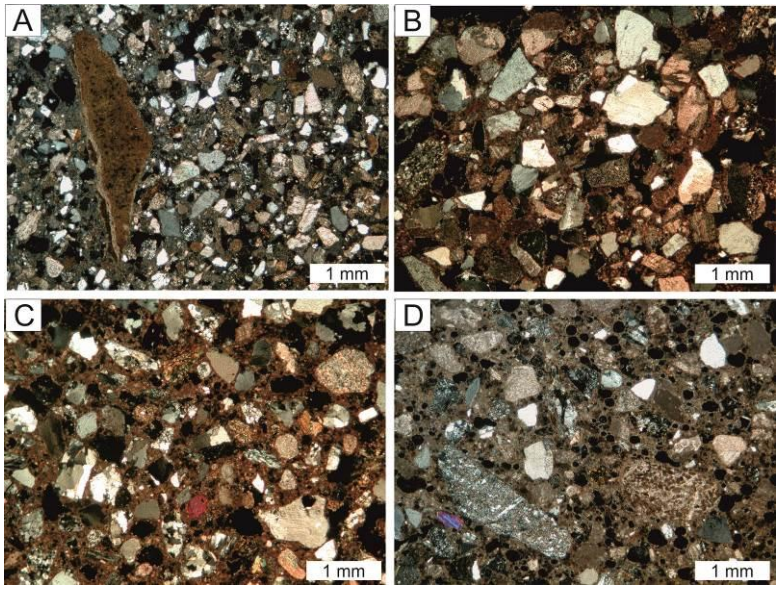

Fig. 2: photomicrographs: a) mortar with lime binder and an underburned binder-related particle (marly limestone, at center left) with fine-grained sand from the Panaro River (sample F3-2C); b) mortar with cement binder, the sand is from the Secchia River (sample E3-1C); c) mortar with cement binder, the sand comes from the Po River (sample E1-1B); d) cement mortar with sand aggregate from a Veneto area river (peloidal Mesozoic limestone, lower right side, sample M4-1A). All samples shown in transmitted light and crossed nicols.

References

Lugli, S., 2010. Dall'Egitto all'Istria: viaggio tra le pietre di Modena. Atti del Convegno "*Geologia urbana di Modena: sostenibilita' ambientale e territoriale*" 21/11/2008, Modena. Geologia dell'Ambiente, 2/2010, 31-41.

Lugli S., Marchetti Dori S. and Caroselli M., 2013. Petrography of mortars and plasters as a tool to distinguish construction phases for the historical buildings of the Modena area (Northern Italy). Proceedings of the 3rd Historic Mortars Conference, 11-14 September 2013, Glasgow, Scotland.

Lugli, S., Marchetti Dori, S. & Fontana, D., 2007. Alluvial sand composition as a tool to unravel the Late Quaternary sedimentation of the Modena Plain, northern Italy. In: S*edimentary Provenance and Petrogenesis: Perspectives from Petrography and Geochemistry*. ed. Arribas, J., Critelli, S., and Johnsson, M.J., Geological Society of America Special Paper: 420, 57-72.

Lugli,S., Marchetti Dori, S., Zolli, K., Melloni, C., Pedrazzi, S., Maiorano, C. , 2010. I materiali da costruzione nell'interno della torre: le pietre, i mattoni, le malte, gli intonaci. In: L*a Torre Ghirlandina: storia e restauro*, eds Cadignani, R. e Lugli, S., Sossella Editore, 178-189.