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Materials decay and environmental attack in the *Pio Palace* at Carpi: A holistic approach for historical architectural surfaces conservation

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Abstract

Since the XIV century the Pio Palace in Carpi (MO, Italy) has been subjected to many additions and rearrangements and, in the last decades, to wide restoration works. Nevertheless the XVII century main portal has not been restored yet, due to its complex and peculiar surface alteration forms in comparison with the other parts of the building, and still suffers a deep decay and degradation by complex chemical-physical processes.

The portal materials were investigated through a multidisciplinary approach, which the authors have outlined during diagnostic investigations in several historic buildings. The diagnostic protocol has given fully satisfactory results in view of a future restoration work.

Keywords: Historical buildings; Materials decay; Multidisciplinary diagnostic protocol; Environment; Brick; Moisture

1. Introduction

The most ancient nucleus of the Pio Palace in Carpi (Modena, Italy) dates back to XIV century, but the largest additions were made during the XV century [1,2]. At the beginning of the XVI century, on behalf of Alberto III Pio, the different parts were rearranged into a unitary princely palace, with the construction of the Renaissance facade, attributed to Baldassarre Peruzzi [3], on the main square (Fig. 1). In the same century, in the middle of the facade, a clock tower was built, but due to a collapse it was rebuilt between 1625 and 1637 in the present form (Fig. 2). After a period of abandonment, in 1863 the building was bought by the Carpi Municipality and restored in successive stages during the last century. In one of the first restoration works, the frescoed plaster was removed from the clock tower and the bricks left uncovered, according to a practice very common at the time [1,4].

In the years 1997–1998 the tower went through an overall restoration intervention, involving cleaning, substitution of the damaged bricks and the mortars external layers, creation of a barrier against water capillary rise by resin injection, application of a macroporous plaster on the internal surfaces of the walls, etc. Only the ashlar-worked (*''bugnato''*) brick portal, suffering from a deep decay with no similarity in any other parts of the building, was kept out from that restoration and left in its former state (Fig. 2). At present, the portal, which represents the monumental entrance to the building, needs effective works for its safeguard. Diagnostic investigations have therefore been carried out to disclose the causes of its heavy and peculiar deterioration (Fig. 3), using a multidisciplinary approach. This approach allowed to outline an integrated diagnostic protocol taking into account all possible external (moisture, environment, wind, etc.) and bulk (materials and manufacturing technology, microstructure and its transformations, etc.) causes, as well as historically proved transformations, which may lead to such a complex decay of architectural external surfaces.

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Fig. 1. The Pio Palace in Carpi.

Fig. 2. The clock tower at the Palace main entrance.

Fig. 3. Decay of the bricks in the portal of the clock tower.

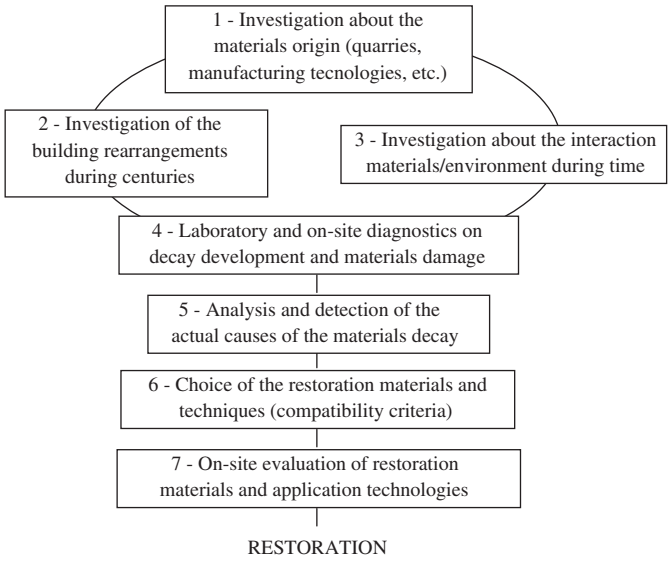

Fig. 4. A diagram of the multidisciplinary approach to diagnostics.

2. Diagnostics for restoration: layout for a protocol

The main purpose of diagnostics on historical surfaces is to detect the characteristics of the original/restored materials and find out all the actual causes of the decay, in order to provide the necessary information for the restoration design, i.e. for:

1. choosing effective restoration techniques (cleaning procedures, anti-dampness systems, etc.);
2. detecting the incongruous materials to be removed from the building;
3. evaluating the chemical, physical–mechanical, biological and philological *compatibility* of the restoration materials with the existing ones and with their transformation products;
4. finding substitution materials for the irrecoverably damaged ones [5–7];
5. assuring a suitable durability to the restoration works.

Unfortunately a poor diagnostic investigation often leads to useless restoration works or, in the worst cases, to further damage to architectural heritage: a multidisciplinary approach is therefore needed. This approach has been set up after several diagnostic surveys carried out by the authors in historic buildings [8–10] and is summarised in Fig. 4: this paper deals with points 1–5. Laboratory and on-site tests must be continually related to