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Case study

A study on the cement-based decorative materials in the San Fedele Church in Milan

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ABSTRACT

Cement-based materials have been used since the 19th century for different decorative purposes, and a high levels of expertise has often reached in reproducing or restoring even quite elaborated stoneworks. An important example is the application of cement-based decorative materials on the façades of the San Fedele church in Milan. The church, built in the 16th century and characterized by the presence of pinkish-yellowish Angera stone on the façades, was subjected, especially in the 20th century, to several restoration works. Damaged decorative elements of the façades as well as portions of its structural elements were replaced or covered in the last century by "stone imitating render", made with cementitious materials which imitate the original Angera stone. In this study, several samples of cement-based decorative materials, collected from different elements of the external façades of the Church, were characterized by several analytic techniques (thermogravimetric analysis, X-ray diffraction, scanning electron microscopy and IR analysis), in order to investigate both their microstructure and composition, how the chromatic aspect of the cementitious materials were obtained and their conservation state and to provide useful information for the possible reproduction of materials with comparable appearance to be used in a further restoration project. Results showed that the cement-based materials and decorations were obtained by the application of different layers of renders; in particular, the colour and texture of finishing layer were achieved by blending the binder with fine dolomite particles, probably obtained by grinding the Angera stone. This technique not only allowed an amazing reproduction of the original stone, but also resulted in a durable protection, since the cement-based decorative materials did not show any significant degradation phenomena in the polluted environment of the centre of Milan.

1. Introduction

In the restoration of historical buildings the characterization of ancient mortars and renders, used for the masonry structures and decorations, is crucial in order to fulfil conservation requirements aimed at preserving the original materials or integrating them with new compatible materials which simulate the original ones [1–5]. As a matter of fact, in the restoration works made in 19th and 20th century, decorations in "stone imitating render" made with cement-based materials [6–8] are often present in many buildings in Northern Italy, and the San Fedele church in Milan (next to the Scala Theatre) is an outstanding example [9].

San Fedele church was built around the former small church called *Santa Maria alla Scala in San Fedele* and it was partly designed by Pellegrino Tibaldi in 1569, as an assignment from Saint Carlo Borromeo. Tibaldi's work was continued by Martino Bassi, and the dome and crypt were designed by Francesco Maria Richini. Down through the century, but especially in the 20th Century, due also to

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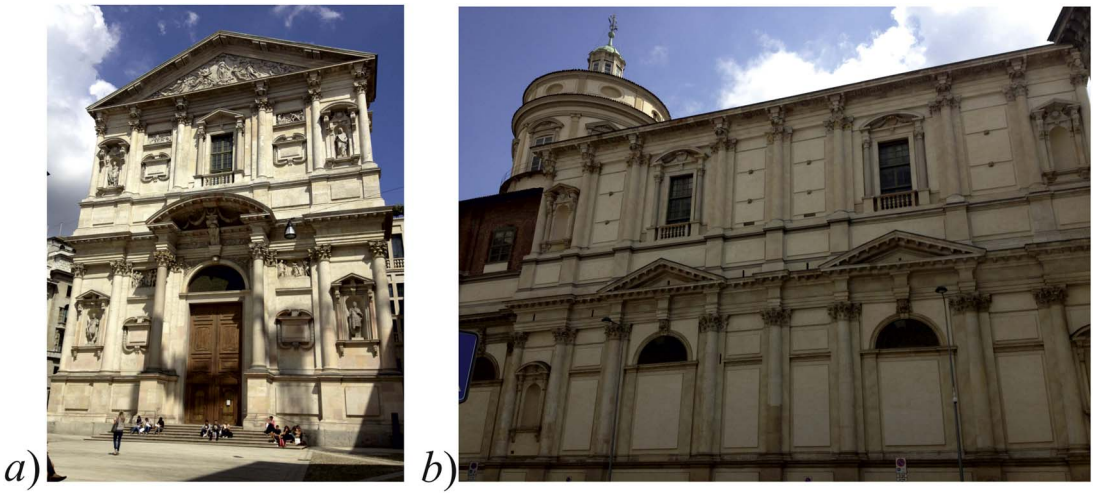

Fig. 1. Main (a) and left (b) façade (b) of San Fedele Church.

the damages occurred during the Second World War, several restoration works were carried out [10].

The church has a main façade, exposed to south-west, of two orders (indicated as *I* and *II*) with a total of twelve pillars made of Angera stone, donated by S. Carlo Borromeo, with a gable on the top. Due to the urban contest of the centre of Milan in which the church is placed, the left façade, exposed to North-West, is conceived in close unity with the main façade (Fig. 1). In the left façade the two orders are separated by a massive belt-course and the columns mark spaces of different dimensions, with niches or rectangular elements (the latter indicated as *sfondati*) (Fig. 2).

The structure of the church is mainly made by brick masonry. The masonry is covered by Angera stone, a dolomia with pink and yellow colouration, extracted around the Maggiore Lake in Northern Italy; some structural (columns) and decorative elements are entirely made of Angera stone. Unfortunately, due to high porosity and calcareous composition, this stone is highly susceptible to atmospheric damage, especially in the urban environment of Milan [11]. The damage on the façades was observed since the early decades of the 20th century and the deteriorated decorations and renders were replaced with cement-based decorative materials, which imitated the original stone.

Restoration works were reported in the historical literature, for instance in the 1950s and in the 1960s, however no detailed documentation is available. In the 1970s the cleaning of the main façade through a sandblasting and the application of 'polymer paint' are reported; consolidation with 'resins' are mentioned on the elements of the left façade. In the 1980s the paint applied on the main façade was removed and the surfaces were consolidated with the same 'resin' used for the left side [10].

At the beginning of the 21st century a new conservation restoration project aimed at the conservation of the external façades of the church was carried out [12]. In order to support these intervention strategies, in 2003, a detailed investigation on the cement-based decorative materials used as stone imitating render and their conservation state was carried out. In this study, the cement-based decorative materials of the San Fedele church were characterized on the basis of X-ray diffraction and thermogravimetric analysis, FT-IR analysis and scanning electron microscopy in order to determine their structure, composition and conservation state. Possible

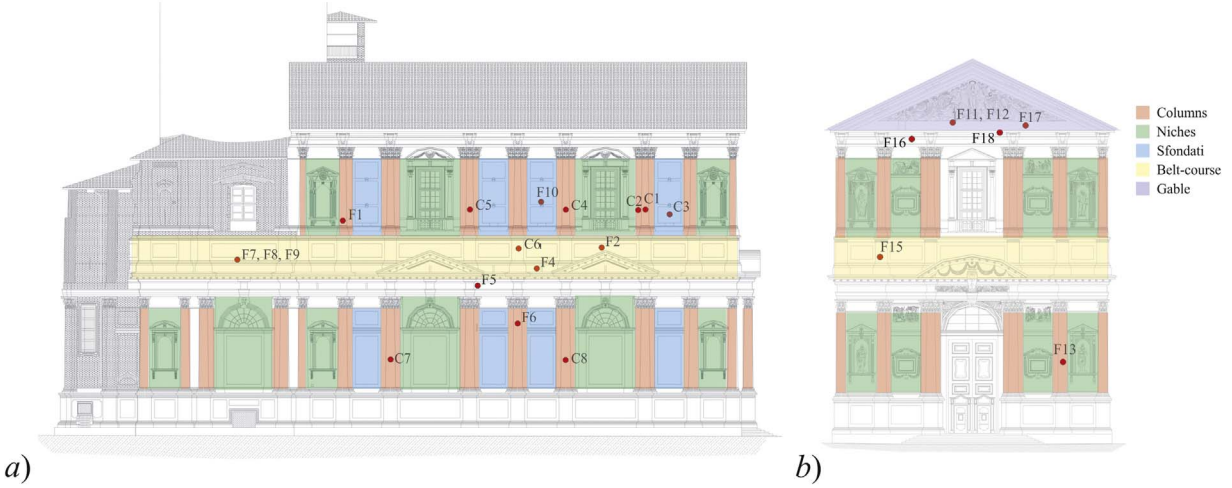

Fig. 2. Indication of the main elements and sampling: left side (*a*) and main façade (*b*) of San Fedele Church.