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Conservation studies in weathered sandstone from the romanesque façade of the Church of San Julian (Salamanca, Spain)

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Abstract

The North façade of the Romanesque Church of San Julian, in Salamanca (Spain), built with Villamayor sandstone, is heavily weathered, due to damp rising from the basement, salt precipitation, contamination of run off and subsurface water and to the nature of the stone itself, containing swelling clays and calcium carbonate, among other constituents. Such weathering has increased since resurfacing of the square by the church, thus giving rise, unfortunately, to accumulation of water close to the building. Weathering even reaches arenization in some parts of the façade, also altering the top part of the main entrance, where there are Romanesque statues and fine carvings, and this area needs urgent consolidation to avoid further deterioration. In the first stage, several weathered stones from the lower parts of the façade, without any artistic value, have been substituted. Consolidation tests are currently being, carried out on these stones in order to assess their behaviour before performing definitive consolidation work on the upper part of the façade.

Keywords

Sandstone, deterioration, conservation, dampness, salts, consolidation.

Introduction

The church of San Julian in Salamanca is located in the historical centre of the city of Salamanca (Spain). Originally built in 1107, it was completely restored in 1582. The material used for building and decoration, as in almost all historic buildings and monuments in the city of Salamanca, is the so-called "Villamayor sandstone", a highly porous stone containing appreciable amounts of smectite (Vicente, 1984; Vicente and Brufau, 1986).

The main entrance, facing the north, meets the corner between Clavel St. and Sexmeros Sq., a sloped, pedestrian area, protected from winds by a nearby building. The pavement around the building is compact, with low permeability and at a slightly higher level than the floor of the church. These facts lead to a high degree of humidity in the walls, by capillary damping of subsurface

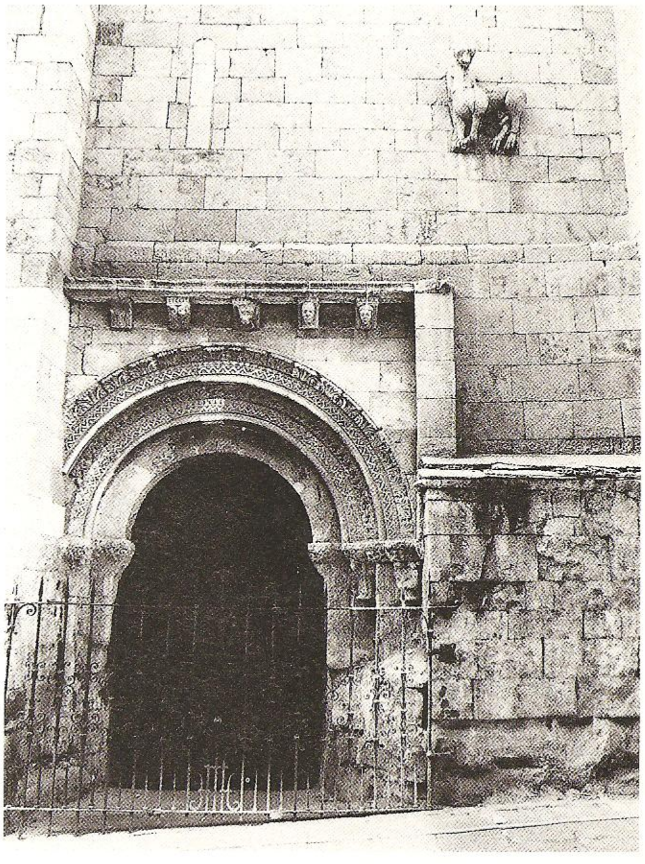

Plate 1. - The Romanesque façade is heavily weathered, the lower parts of the buildings are arenized and many of the decorative components are broken.

water, and rain water accumulating around the building.

The Romanesque façade is heavily weathered (plate 1), the lower parts of the buildings are arenized and many of the decorative components are broken.

The present work reports, a study of alteration forms in the façade the origin of such a weathering is studied, and the response of these materials to consolidation treatments is analyzed.

Stone pathology

The following alterations have been observed in the façade:

- surface deposits: thick loosely held layers of dust and sand, with insect nests. Black crusts have developed in protected areas, some parts being easily removed as flakes;
- arenization: this is the dominant weathering process. It is observed in areas altered by capillary damping and filtration through roofs. Material loss is also observed in low located ashlars;
- deformation and fissure formation: in the highly exposed areas, deformation and partial loss of the decorative motifs has occured. In upper parts (corbels and zoomorphic figures), swelling has led to deformation and even loss of material.

Altogether, these alteration processes have given rise to an serious loss of material.

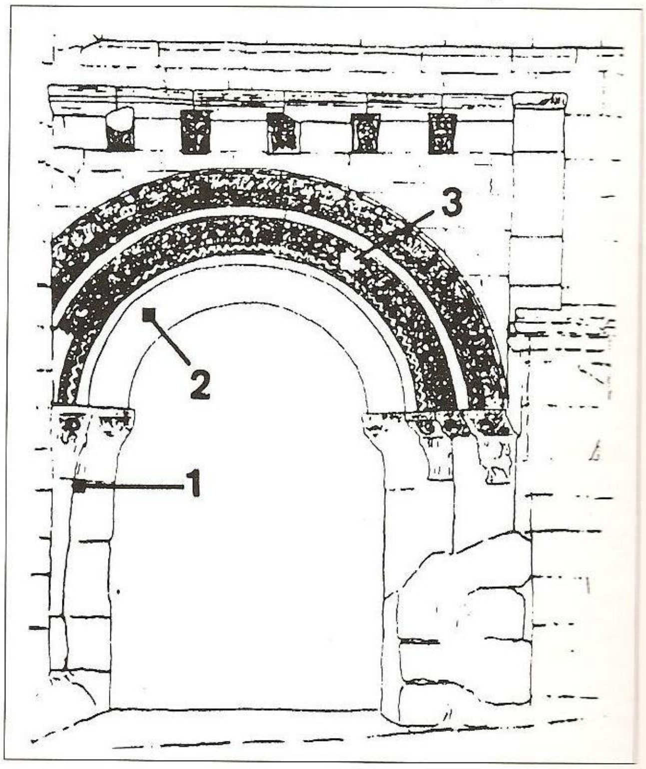

Fig. 1.- The Romanesque façade. Location of sampled zones.

Characterisation of the stone

Sampling has been carried out in less-weathered and heavily altered areas of the building. The location of sampled zones is given in Fig. 1. X-ray diffraction, Differential Thermal Analysis and Thermogravimetric Analysis data can be summarized as follows:

Zone 1. Ashlar in the side column of the façade (1). The mineralogical components are quartz, calcite-dolomite, palygorskite, smectite, feldspars, mica and small amounts of gypsum.

Zone 2. Black film in the unworked part of the Romanesque façade, just above the door (2). It's black, 2 mm thick, and easily peeled off. The internal side is almost white, and consists of quartz, feldspars, clay minerals (smectite) and iron oxides (goethite), while the external side is black and, in addition to quartz, gypsum and calcite-dolomite, it contains appreciable amounts of salts, mainly sodium, magnesium and potassium salts.

Zone 3. Worked part of the arch in the Romanesque façade (3), heavily weathered. The composition is rather similar to those of samples from zone 1: quartz, calcite-dolomite, palygorskite, smectite, feldspars, mica and gypsum.

Zone 4. Lightly weathered parts of the façade. Once the surface patina is removed, the composition of the remaining stone is quartz, calcite-dolomite, palygorskite, smectite, feldspars and mica.

From the results given above, we can conclude that the stone used to build the façade of the Church of San Julian is a rather uncommon Villamayor sandstone, containing carbonates. This composition has been previously observed (Vicente, 1984) in two Romanesque churches in Salamanca (San Julian and San Blas), and also in one of the quarries studied.

The heavy weathering observed in the present case is mainly due to humidity because of damping capillarity with water containing a high level of ions, thus giving rise to salt precipitation upon water evaporation. In addition, the high porosity of the stone favours the penetration of fluids, and the presence of plastic and swelling clays gives rise to slabs formation and arenization, as the two main degradation processes of Villamayor sandstone (Vicente et al., 1986). Humidity way also originate from leaking roofs.

Gypsum comes from old, man-made patina, very common in buildings in Salamanca during the XVIII-XIX centuries (Rives et al., 1991) and/or the presence of sulphate in subsurface water, reaching the stone through capillary damping. This lond also explain the presence of sulphates in weathered areas.

Interventions performed and consolidating studies

In a first step, the surface of the stone has been washed and restored in order to avoid filtration and water accumulation. Unworked ashlars of highly weathered jambs have been substituted (plates 2 and 3). Consolidation studies have been carried out on removed, altered ashlars in order to gain knowledge of the response of the material before performing such a consolidating treatments on the building itself.

An in situ consolidation study has been also carried out on the left hand side column, capital and ashlars, and on the first keystone in the left hand side of the two inner archuivolts of the arch. This part of the façade was chosen because it was very heavily damaged and the area was large enough to obtain significant results. Tegovakon V from Th. Goldschmidt, S.A. was applied with cotton poultices. Treatment lasted for along three days, starting with a diluted solution in chlorothene, the concentration being steadily increased, and the whole area protected with a plastic cover, to slow down evaporation.

When the cotton poultices were removed the stone was hardened, with no material loss, but showing surface cracks. Such cracks did not appear, however, when the treated area was smaller, with thinner alteration.

For the laboratory studies, the removed stones were cut into 5 x 5 x 5 cm cubes, witch were treated by immersion (Normal 20/85) in 40% solutions of RC-70 and RC-80 from Rhône-Poulenc, and Tegokavon from Goldschmit. The treated samples have been submitted to standard studies to determine the effectiveness of the different treatments. Artificial damage of the treated samples has been performed in a simulation chamber.

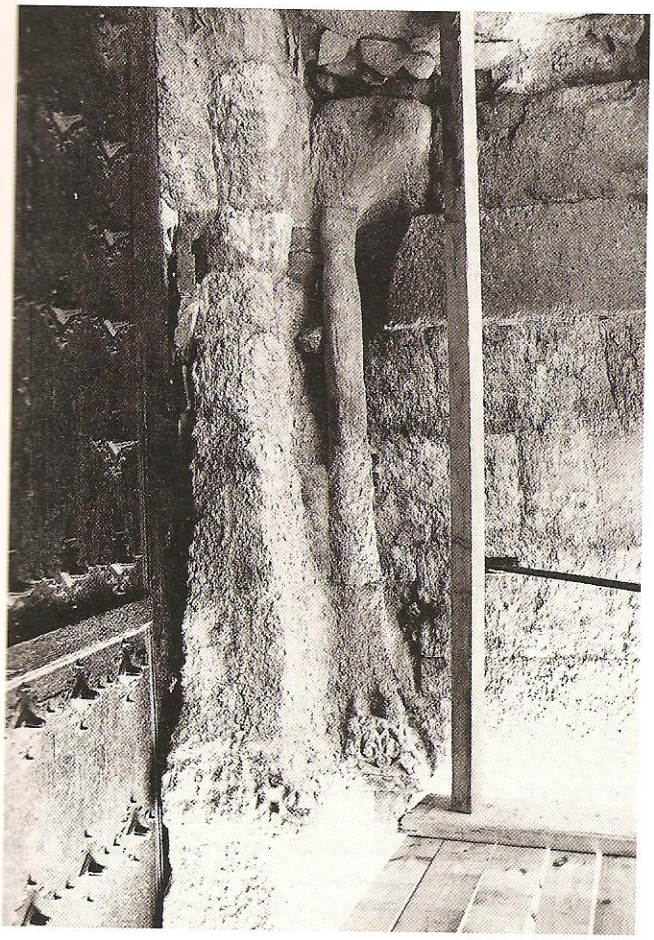

Plate 2.-Unworked ashlars of highly weathered jambs.

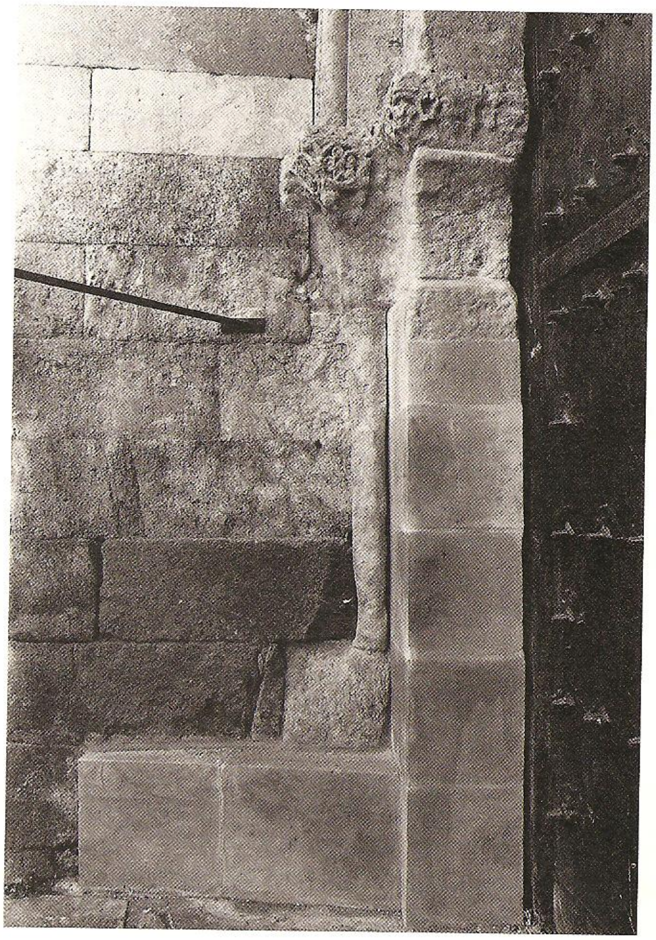

Plate 3.-Substituted ashlars.

Conclusions

The following conclusions can be drawn from the studies carried out so far:

- The Romanesque façade of the Church of San Julian (Salamanca, Spain) shows different, highly damaged areas. Immediate treatment is required in order to avoid the total destruction of the monument.
- Deterioration proceeds usually to arenization, although crust and slab formation is also observed.
- The inherent properties of the material used in the building and the formation of salts somewhat favours arenization in areas sulject to humidity.
- Such weathering has become even worse after the recent resurfacing of the square around the monument, witch has proved conducive to water accumulation, and contamination of subsurface water.
- Consolidating treatments should be only performed in strictly necessary areas, due to the risk of loss of worked parts. Consolidating agents are to be used in dilute solutions in order to avoid higher hardness and lower porosity of the treated stones that in well preserved sandstone.

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