A NEW CLADDING SYSTEM USING LOW STRENGTH SANDSTONE IN PRECAST CONCRETE PANELS FOR BUILDING FAÇADES

Carmen Vielba-Cuerpo1*, Francisco Hernández-Olivares2, Benito Lauret-Aguirregabiria2

1Department of Infrastructure, Aerospatia Systems and Airports, Universidad Politécnica de Madrid, Plaza Cardenal Cisneros 3, 28040 Madrid, Spain
2Department of Construction and Architectural Technology, Universidad Politécnica de Madrid, Avenida Juan de Herrera 4, 28040 Madrid, Spain

Abstract

The monumental architecture of Salamanca (Spain) is directly related to golden sandstone obtained in the neighbouring quarries. The characteristics of this stone as high porosity, poor adherence with mortars, and low moisture sensitive strength, prevent the use of thin plates simply adhered to the brickwork and make it impossible to be used in ventilated façades. To solve this low strength problem a construction system was developed decades ago: steel nails partially hammered to the back side of plates and joined to the brickwork by mortar. The heads of the nails remain inserted in the mortar working as anchors between the stone and the mortar. A new improved use of this traditional construction system is described in this presentation. Precast concrete panels are cladded with stone plates by using the nails technique. An experimental assessment of this system and their safety against wind suction is discussed.

Keywords: sandstone, precast concrete, architectural heritage

1 INTRODUCTION

Nowadays, developed societies have the important challenge of preserving their architectural heritage as a testimony of the past. Nobody has doubts about the importance of preserving important monuments, as churches, palaces or castles, but the importance of preserving the historical urban ensembles in order to maintain the identity of our cities and countries must also be considered.

Most monumental architectures are based on the use of the stone with the idea of giving solidity and durability to the constructions. Usually, the stone used is supplied by the natural environment in which the buildings are located. So the architecture of some regions is directly related to their geological resources and many historical cities and villages from a distinctive region are joined to the particular colour of a particular stone. In those cases, the preservation of the urban ensemble requires that the new constructions align with the ancient building not by imitating the architectural forms but, perhaps, by using the same materials in a new way. That links the new and the old architectures while the first one is free to use its proper language and individual style.

In this sense, many historical towns have laws to protect their urban environmental by imposing the use of specific traditional materials in the new constructions. This is the case, for example, of Salamanca (Spain). The monumental architecture of this town is directly related to sandstone obtained in the neighbouring village of Villamayor. This stone called “Piedra Franca” has a particular golden colour that is one of the characteristics of

* Correspondence to: carmen.vielba@upm.es
the urban ensemble of Salamanca. In this circumstance, the architects have the challenge of preserving the image of Salamanca by using the Villamayor stone in their new works but applying new building techniques, at the same time.

Modern architecture conceives the use of the stone as a soft and thin skin that envelops the building. In Salamanca, the Villamayor sandstone is used in the form of plates placed over the brickwork. The particular characteristics of this stone such as a high porosity, poor adherence with mortars, and low strength, which decreases as the stone water absorption increases, prevent the use of thin plates simply adhered to the brickwork and make its use impossible with ventilated façades. To solve this question, decades ago, a particular construction system was developed. It consists of the use of nails partially hammered in the back side of plates and joined to the brickwork by mortar. With this technique the heads of the nails remain inserted in the mortar working as anchors between the stone and the mortar.

This ingenious technique has been successfully used for decades. In Salamanca, outstanding examples of modern architecture can be seen where this method has been used, as the Convention Centre designed by Juan Navarro Baldeweg. The building incorporates itself into the Salamanca landscape with a dual intention of continuity – by the use of the Villamayor sandstone – and rupture, by the use of the forms and concepts of the new architecture [2].

Nevertheless, the works that involve the use of this technique are quite hard and slow. A new use of this traditional construction system will be proposed to improve it. The idea is to make precast concrete panels cladding with stone plates by using the nails technique. Therefore, to define the clad solution, a research about the resistance of the nails system must be made.

2 PERFORMANCE OF THE ANCHORING NAIL SYSTEM

a. Materials

General

A section of the wall façade built using the nails technique is shown in Figure 1. As it can be observed, the durability of this cladding system depends on the veneer’s resistance to be pulled-off when the wind produces suction over the walls.

The strength has been analyzed making pull-off test over several samples. For performing this test the following materials have been used:

Stone

The Villamayor sandstone is defined as an arkosic-feldespathic sandstone containing between 40 and 70 vol% of quartz grains, 10–30 vol% of feldspars and mica in a clay rich matrix which acts as a cement. The stone dates from the upper Paleogene period and is of fluvial origin. This stone presents high porosity and water absorption and low strength that decreases when it is weathered [3].

The stone used in this research has a total porosity of 36.1 ± 6.2 vol% and an apparent porosity of 30.4 ± 1.1 vol% and their water absorption at 48-h test is of 15.4 ± 1 wt%. Its ultimate compressive strength varies from 9.7 ± 3.3 MPa when it is dry to 1.5 ± 0.2 MPa when it is saturated.

Mortar

The mortar generally used in the nails construction system is a cement mortar with a 1:6 cement/sand ratio. Nevertheless, in this research a mortar 1:3 cement/sand ratio and a mixed mortar of cement and slaked lime 1:1:3 cement/lime/sand ratios have also been considered.