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Proposal for optical method of quality control of the surface of the slabs of natural stone for cladding facades

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Abstract

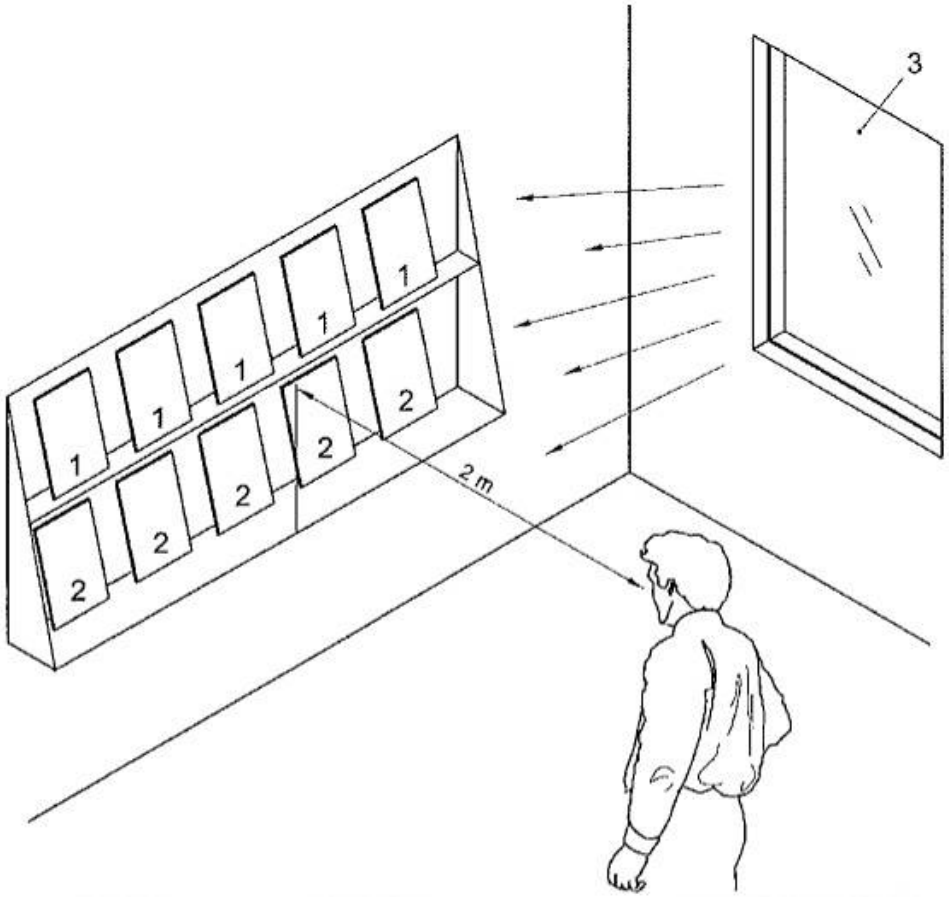
The purpose of this communication is to make a contribution to knowledge about the technical quality assessment of the apparent facade cladding made with slabs of natural stone. Using natural stone as facade cladding has expanded remarkably with the spread of modern methods of stone cutting. The material is presented commercially as natural stone slabs thickness <30 mm and basically is appreciated their aesthetic values. Most of the technical regulations in force preferably appreciate the technical aspects of stone such as stability, quality of fixation, quality ore, etc. However there is a gap regarding the valuation of the final quality of the coating once the stone slabs have been placed in the work of building. Other industries such as graphic arts, painting on metal or textiles, etc. have rules for classifying surface defects considered only from the aesthetic point of view. This paper provides an experience of implementing a draft based method for image recognition systems and subsequent statistical treatment based on the classification of visual anomalies. The interest of this communication is to give technicians on site a simple, affordable and contrasted procedure to quantify the quality of a stone cladding from the aesthetic point of view.

Introduction

The existence of a significant number of surface defects in the stone cladding of the facades of a building advised to proceed:

1 .- Locate the defects
2 .- classify these defects according to a typology
3 .- To quantify the number of defects per unit area and by type.

To answer these questions suggests using the following methodology:



Procedure comparison between sample production and the reference sample: "... it is permissible any visible changes such as cracks, inclusions, cavities, estiolitas and veins, as they are typical of the stone and do not adversely affect characteristics of the stone. "(fig 3, EN 1469)

Description of the technique applied for recognition

We have proceeded to photograph each of the facades with a digital photographic camera model Nikon Coolpix P5100 12 Mpixels resolution, with a normal program exposure and ISO speed index 64. Later these images have been treated with a specific image processing software to correct curvature of the lens.

As the visualization of surface defects of the stone through photography depends on the conditions of environmental lighting (facades oriented north and south) at the time that this has been taking pictures all of them have been homogenized. This homogenization is simple and consists in modifying the initial parameters (0% - 0%) brightness and contrast, face to achieve a comparable image remain on the existing surface discontinuities manifest as possible for their identification on the screen of the computer.

For photos taken at the south orientation the new parameters are brightness and contrast +60% -40%. For photos taken at the north orientation the new parameters are brightness and contrast +70% -30%.

Subsequently, images are desaturated (conversion of color image corresponding to gray levels) to achieve maximum uniformity among all fronts. Each façade front has required taking two pictures, upper and lower, due to their proportions.

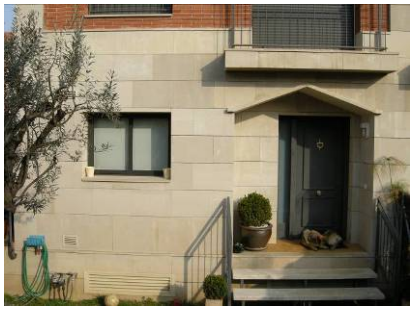
Sample of picture treatments

NORTH top

SOUTH top

NORTH bottom

SOUTH bottom



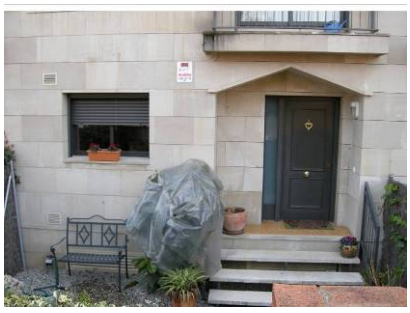
Original pictures

NORTH top

SOUTH top

NORTH bottom

SOUTH bottom



Treatment of the original pictures for the correction of the curvature

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NORTH top
NORTH bottom

SOUTH top
SOUTH bottom

Photographs treated for modifying the brightness and contrast settings, and finally dessaturated

Measurements of the surface of the stone cladding

Lateral facade 1: 11,0 m^2 Principal facade: 70,2 m^2 Lateral façade 2: 11,0 m^2

Understanding the types of defects detected in the stone cladding

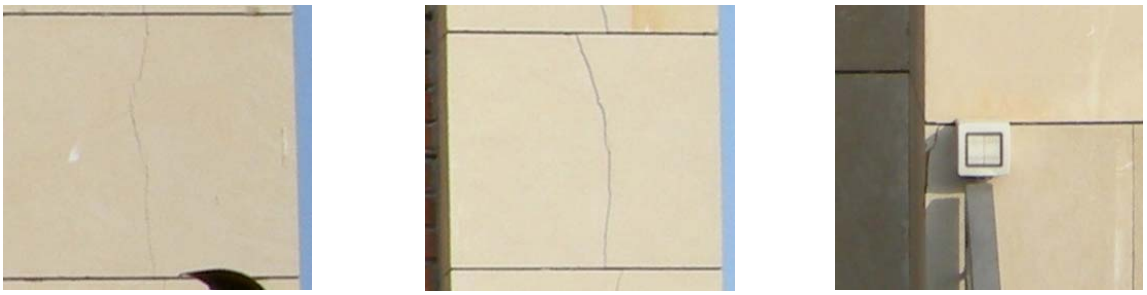
After that, it's typified the different surface defects appreciated. The typing is done through a definition and some representative images.

Anomaly 01: There are stone slabs **notched** when present at certain points of perimeter notches (material losses) caused by impact. The anomaly is presented mostly in the corners of the pieces, however, is also present in some edges.

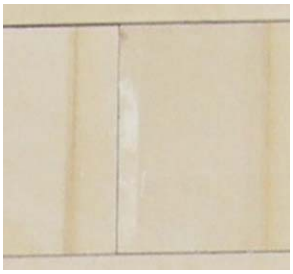
Anomaly 02: There are pieces of stone with **efflorescence** on the surface are manifested when the remains of salt crystals.

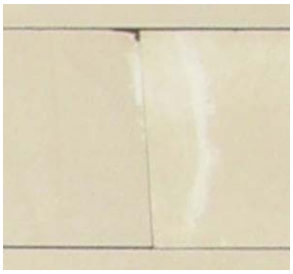
Anomaly 03. There are stone slabs **scratches** when there are material losses in the face of the stone plaque, which follow a linear path parallel to any edge.

Anomaly 04. The plates are **broken** when the cladding has cracks or fissures from side to side plate of irregular shape, which split the board into two halves.

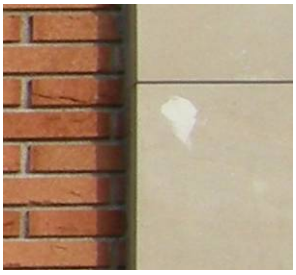
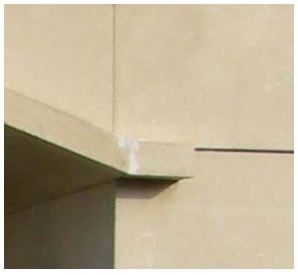


Anomaly 05: There are stone panels with **colour contamination** when, in a relatively homogeneous rock like this, colour aspect are altered in the form of watermarks or pigmentation. In this case these discolorations fall sharply near the ground.

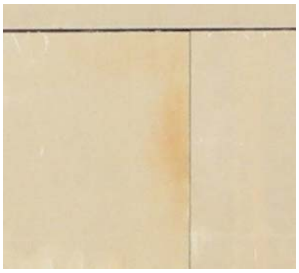
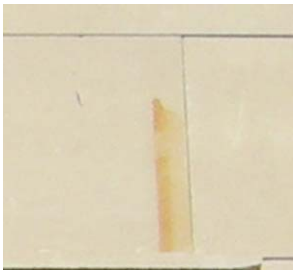
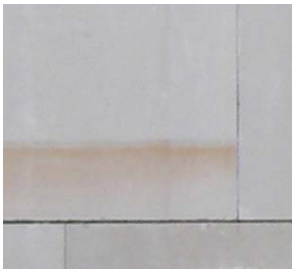




Anomaly 06: There are stone slabs **repaired** when it detects the presence of residual pulp repair in certain points of the plates. Pulp repair cover the corners and edges and cover fasteners and ancillary impacts in the plane of the plates.

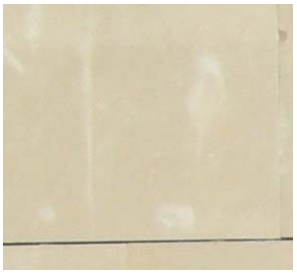




Anomaly 07. There are **marks** on a stone plate when there are patches of linear character and tone that are reddish, in an apparently random.

Anomaly 08. There are stone slabs with specific **impacts** when there is loss of material impact. These losses are non-linear and always located in the plane of the facade panels.





Notched
Efflorescence
Scratches
Broken plates
Colour contamination
Repaired
Marks
Impacts

The imperfections are censed and located on the photographs using coloured circles, the same colour as the type of aberration classified.

Treatment of the original pictures for the correction of the curvature

Photo fully treated, with location and classification of different anomalies

Statistics results

Finally we proceed to the measure, on plan, of the surface of the stone cladding facades presented in order to establish the number of anomalies found per unit area.

	1	2	3	4	5	6	7	8	
	Escrostonaments	Decoloracions	Rascades	P. Trencades	Contaminacions	Reparacions	Marques	Impactes	
Valldaura 22	17	2	8	4	9	3	1	1	
Valldaura 22 lateral	5	1	1	1	0	3	1	2	
Valldaura 24	9	0	5	0	8	9	0	4	
Valldaura 26	9	3	5	1	10	7	1	2	
Valldaura 26 lateral	4	0	1	0	2	3	3	1	
Valldaura 28	7	2	12	4	17	9	5	3	
Valldaura 28 lateral	8	0	0	0	0	4	2	1	
Valldaura 30	6	0	3	1	14	8	4	4	
Valldaura 32	8	2	1	4	11	12	0	5	
Valldaura 32 lateral	3	0	1	0	3	2	2	0	
Coromines 13	11	1	3	0	9	15	3	2	
Coromines 13 lateral	8	0	0	0	1	4	0	1	
Coromines 15	7	0	1	0	9	13	6	1	
Coromines 17	8	1	2	0	7	22	6	3	
Coromines 17 lateral	7	0	0	0	2	2	1	0	
Coromines 19	9	2	3	0	1	9	4	2	
Coromines 19 lateral	10	0	0	0	0	2	3	2	
Coromines 21	9	1	3	0	4	10	2	0	
Coromines 23	6	2	3	0	5	9	9	0	
Coromines 25	4	2	7	0	7	7	6	2	
Coromines 25 lateral	1	0	0	0	1	3	0	0	
TOTAL CASOS	**156**	**19**	**59**	**15**	**120**	**156**	**59**	**36**	**620**
	25,2%	**3,1%**	**9,5%**	**2,4%**	**19,4%**	**25,2%**	**9,5%**	**5,8%**	**100,0%**

Conclusions

The technique applied in this case has proven to be able to answer the following questions raised:

1.- Location of the precise anomalies was performed on photographic support
2.- Classification of these defects as a typology of eight types of surface defects.
3.- Quantification of the number of defects per unit area: a simplified statistic has shown that the level of defects is visually almost 1.6 defects per m2 of cladding..

References: EN 1469 Natural Stone Products. Slabs for cladding. Requirements. November 2004. Requirement 4.2.3 Visual appearance