CERAMICS BRICK COLOUR MODIFICATIONS PRODUCED BY THE SUPERFICIAL PROTECTIONS.

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SUMMARY

The investigation analyzes the variation of superficial properties, COLOUR and LUMINOSITY, sustained by the ceramic material protected with transparent anti-graffiti painting [1].

After the investigation, it can be concluded that the ceramic pieces that were treated with anti-graffiti paint had different tones than the original which were not treated with the paint.

INTRODUCTION

Ceramic is a construction material which is widely used for façades. All façade materials are exposed to graffiti painting. These materials stand continuous surface abrasions due to cleaning methods used to eliminate graffiti. The use of the protective anti-graffiti paints are to preserve, by previous application, the characteristics of the construction material without altering the aspect of its surface.

The objective of the investigation is to show, by quantification, that the protective coating can also alter the superficial qualitity of the base material.

To limit the scope of the analysis and establish the methodology to be used, the present study addressed the effects of these coatings on porous brick only, essentially in connection with variations in colour.

Graffiti-proofing is paint and as such penetrates into the pores of the material to which it is applied. This, together with its adhesion to the surface, modifies the surface properties of the material and changes its appearance accordingly [2].

The following investigation observes, analyzes and quantifies the amount of incidence which the four types of most commonly used commercial polymers undergo, based on the four different commercial types of ceramics.

BACKGROUND THEORY

Paint adheres to other materials due to a number of interfacial factors, but essentially due to the difference in tension between the two surfaces. Protective treatments (graffiti-proofing) are designed to equalize the surface tension of the underlying material and the paint typically used for graffiti.

The polymeric composition of graffiti-proof coatings affords these compounds a lower surface tension than the construction materials to which they are applied, to ensure that the two will bond. But since any paint (with a polymeric structure) brushed or sprayed onto this protective coating also has a low surface tension, it will adhere only loosely; in other words, the weak (Van der Waals and hydrogen, as opposed to strong ionic, covalent or metal) bonds formed in the absence of differences in surface tension can be readily severed [3].

The macromolecules in copolymers owe their high mechanical strength to the inter-crossing of their molecular chains. The acrylic acid in one of these chains raises copolymer polarity, thereby improving its adhesion to other materials. The other chain, polyurethane, equalizes the surface tension between any future graffiti and the graffiti-proofing, thereby precluding any possible bonding between the underlying material and the paint.

A decline in the surface tension values of materials also hastens the soiling that takes place when chemical compounds react with the surface components, forming strong or weak bonds. In polymeric materials Van der Waals forces - bonds with a lower strength value than in any other type of material- account for the bond strength value of the surface. But at the same time, the polar charge in Van der Waals forces heightens the electrostatic attraction of the surfaces involved, which interact with environmental dirt and chemical compounds in the air, even at a distance. The result is that the surfaces exposed to the air are readily soiled but are readily cleaned (provided the cleaning agents used do not contain solvents), because the chemical bonds involved are weak [4].

Given the different causes in the types of polymers used in the various commercial coatings, each has a specific surface tension that interacts differently with the underlying material, giving rise to specific adhesion characteristics. Moreover, since deterioration and ageing also differ depending on the polymer, each product soils in a specific manner and the perceived change in texture and colour of the material to which it is applied is equally characteristic. The purpose of the present study is to analyse and observe the impact on facing brick of the four types of polymers most commonly used by graffiti-proofing manufacturers.

EXPERIMENTAL

Standard

There are no standard procedures for conducting colour and texture trials on brick specimens.
In light of the lack of any standard for systematically analyzing surface change, a methodology to obtain objective and quantifiable results was designed and developed.

Instruments used

CARTON MARES binocular microscope with a Moticam 480 digital camera.
MOTIC IMAGES 2000 software, version 1.2.
Photoshop software, versions 6 and 7.

METHODOLOGY

The methodology used was based on previous research [5] that proposed Photoshop software for colour observation and analysis. Based on the investigations conducted on the cement mortar, the procedures described for these experiments were adapted for use with ceramic pieces.

The pieces are classified by type of brick and side used (front and back). The samples were obtained from the same ceramic brick, from each side, as well as on the left and right of the brick. The left side of the brick is conserved in a dry place, without exposure to light in order to have a permanent reference of the original colour. The right side of each piece is covered with different paints. This process allows us to measure and compare the results at different times, between the neutral originals (left side of brick) and the painted side (right side).

The method of classification of the test material is explained in the following point, "**Development of test material**".

The physical measurement of colour is obtained through the method of computer system based on colorimeters, photo-colorimeters, spectrometers, that determine the coordinates of the analyzed colour.

Besides the coordinates of the colour, the physical method for the value of luminosity of the sample is also obtained.

In this way, the colour remains determined by the average value of each of the spaces of colour that it is composed of (basic colours) and for the value of luminosity that corresponds to it.

In order to foresee the colour and luminosity values the histograms of the image are checked with the indicated software. The histogram of the image is made of a graphic which shows the density of pixels of each space of colour that the image is composed of.

Development of test material

Bricks

Different types of brick facing (textured, extruded, moulded) were chosen for the analysis of porous brick behaviour. The three different types of brick used were:

- Textured brick (**R**)
- Normal industrial extruded facing brick (**I**)
- Industrial moulded facing brick (**A**)

Each (26-cm) brick specimen was split face-wise down the middle, halving its initial length. The left half was set aside for possible subsequent use of the same sample. The front and rear sides of the brick were also defined, and the "front" side only used in this study.

Coatings

From the wide range of coatings on the market, some intended for temporary use (which come off when a vandalized surface is cleaned and must be re-applied) and others for permanent use (the coating remains intact when the paint is removed), the following types were chosen to determine the changes induced by each on the different kinds of materials to which they are applied [6]:

1- Coating n° 1
Wax-base, removed with pressurized water at 90 "C; treatment must be re-applied after the paint stain is removed.

2- Coating nº 2
Two-component system varnish made with aliphatic isocyanate (polyurethane)-catalysed hydroxyl-acrylic resin.

3- Coating nº 3
Primer: acrylic copolymer in a water base.
Finish: polyol-crosslinked isocyanate (coating with several OH groups) in a (polyurethane) solvent base, more solvent-resistant than the primer.

4- Coating n° 4
Primer: acrylic compound in a water base.
Finish: two-component system varnish in polyurethane base.

Specimen classification

The specimens were identified with initials and numbers that described their properties:

Brick type (R, I or A)
Coating or treatment type (1, 2, 3 or 4)
Side (front, F or rear, R)
Half (right, D; left, I)

Example: **R1FD**: textured brick coated with graffiti-proofing 1, front side, right half.

TESTS RESULTS

The images of the processed and unprocessed samples, along with the colour and luminosity data deduced from the histograms, are given in Tables 1, 2 and 3. Rows and columns compose each table.

Each row shows the relation between the images of the brick specimen right side uncoated and the specimen right side coated, as well as the histogram values of the image. Those values include the luminosity, red, green and blue.

Each column shows the histogram values coating types image (nº 1,2,3, and 4)

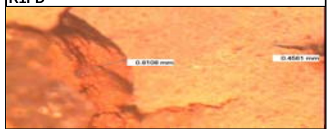
Table 1 reflects the results of the texture bricks specimen.

Table 2 reflects the results of the normal industrial extruded bricks specimen.

Table 3 reflects the results of the industrial moulded bricks specimen.

TABLE 1
TEXTURED BRICK SPECIMENS

UNCOATED SPECIMEN
R1FD

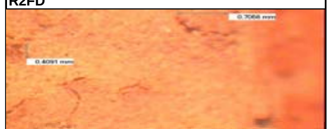


Histogram Values	
Luminosity	176,81
Red	235,7
Green	161,52
Blue	98,19

COATED SPECIMEN COATING
R1FD **Nº 1**

Histogram Values	
Luminosity	153,00
Red	190,90
Green	142,66
Blue	105,16

UNCOATED SPECIMEN
R2FD

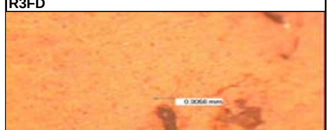


Histogram Values	
Luminosity	175,84
Red	249,06
Green	153,56
Blue	96,38

COATED SPECIMEN COATING
R2FD **Nº 2**

Histogram Values	
Luminosity	160,52
Red	204,30
Green	147,22
Blue	112,48

UNCOATED SPECIMEN
R3FD



Histogram Values	
Luminosity	182,11
Red	149,38
Green	163,65
Blue	97,69

COATED SPECIMEN COATING
R3FD **Nº 3**

Histogram Values	
Luminosity	156,69
Red	195,98
Green	145,97
Blue	107,11

UNCOATED SPECIMEN
R4FD

Histogram Values	
Luminosity	185,48
Red	250,48
Green	168,31
Blue	100,21

COATED SPECIMEN COATING
R4FD **Nº 4**

Histogram Values	
Luminosity	160,10
Red	202,17
Green	148,59
Blue	107,09

TABLE Nº 2
NORMAL INDUSTRIAL TEXTURED BRICK SPECIMENS

UNCOATED SPECIMEN
I1FD:

Histogram Values	
Luminosity	154,00
Red	247,34
Green	121,73
Blue	72,61

COATED SPECIMEN COATING
I1FD Nº 1

Histogram Values	
Luminosity	153,12
Red	215,21
Green	133,41
Blue	90,81

UNCOATED SPECIMEN
I2FD

Histogram Values	
Luminosity	138,48
Red	229,70
Green	105,67
Blue	65,71

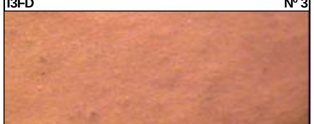
COATED SPECIMEN COATING
I2FD Nº 2

Histogram Values	
Luminosity	130,65
Red	191,83
Green	109,21
Blue	79,89

UNCOATED SPECIMEN
I3FD

Histogram Values	
Luminosity	146,24
Red	242,83
Green	112,04
Blue	66,30

COATED SPECIMEN COATING
I3FD Nº 3

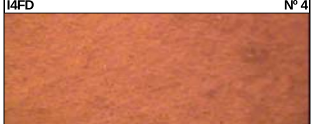


Histogram Values	
Luminosity	152,47
Red	208,63
Green	133,36
Blue	103,00

UNCOATED SPECIMEN
I4FD

Histogram Values	
Luminosity	143,59
Red	237,05
Green	110,23
Blue	67,77

COATED SPECIMEN COATING
I4FD Nº 4



Histogram Values	
Luminosity	132,22
Red	195,98
Green	110,43
Blue	76,46

TABLE Nº 3
INDUSTRIAL MOULDED BRICK SPECIMENS

UNCOATED SPECIMEN
A1FD:

Histogram Values	
Luminosity	150,14
Red	247,03
Green	115,84
Blue	69,88

COATED SPECIMEN COATING
A1FD Nº 1

Histogram Values	
Luminosity	150,42
Red	210,54
Green	131,47
Blue	89,41

UNCOATED SPECIMEN
A2FD

Histogram Values	
Luminosity	147,37
Red	242,34
Green	114,00
Blue	67,33

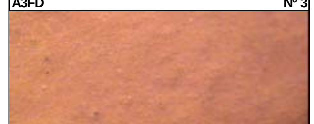
COATED SPECIMEN COATING
A2FD Nº 2

Histogram Values	
Luminosity	140,40
Red	198,33
Green	121,92
Blue	82,87

UNCOATED SPECIMEN
A3FD

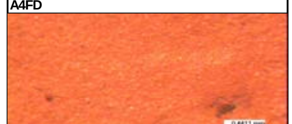
Histogram Values	
Luminosity	149,99
Red	245,65
Green	116,28
Blue	69,94

COATED SPECIMEN COATING
A3FD Nº 3



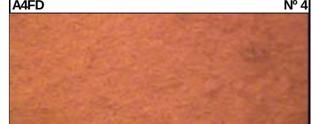
Histogram Values	
Luminosity	157,76
Red	213,08
Green	139,38
Blue	106,64

UNCOATED SPECIMEN
A4FD



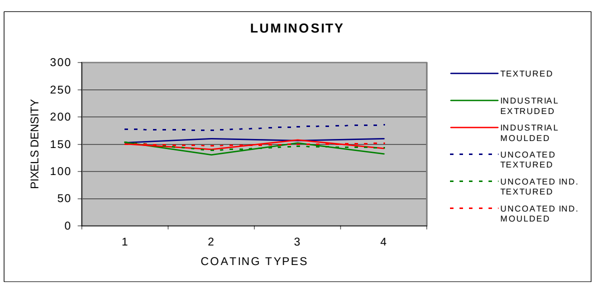
Histogram Values	
Luminosity	151,39
Red	247,37
Green	117,00
Blue	71,26

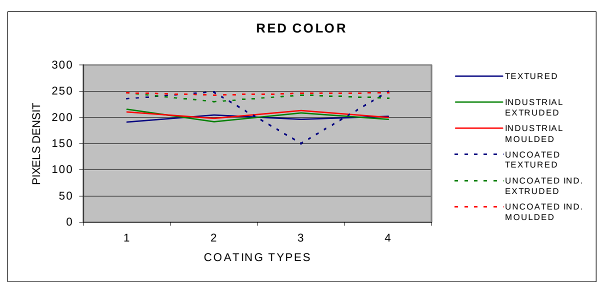
COATED SPECIMEN COATING
A4FD Nº 4

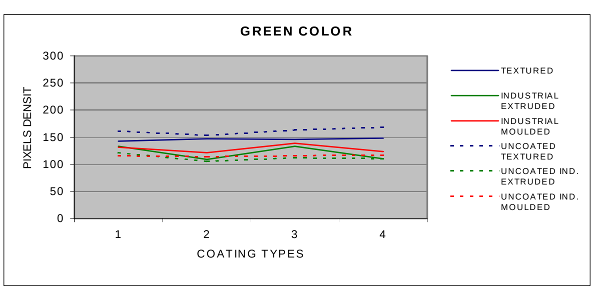


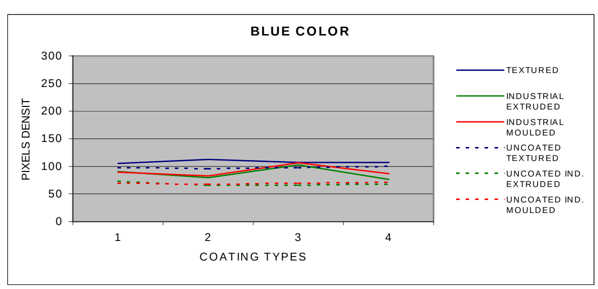
Histogram Values	
Luminosity	142,29
Red	200,27
Green	123,40
Blue	86,78

TABLE Nº4: GRAPHS COMPARING VALUES FOR COATED AND UNCOATED SPECIMENS.









COATING TYPES:
1- Microcrystalline wax in water base.
2- Two- component system based on polyurethane-catalysed hydroxyl acrylic resin.
3- Acrylic copolymer in water base.
4- Acrylic primer in aqueous dispersion and two-system component varnish finish in polyurethane base.

Table 4 shows the comparative values between the uncoated and coated bricks specimens in relation with the chromatic spectrum of the average value of each colour types and the luminosity values.

Table 5 shows the values of the table 4 with the percentages of the coated brick specimen values respect the uncoated brick specimen values.

TABLE Nº 5

COATING TYPES	LUMINOSITY	RED	GREEN	BLUE	
1	(-) 24,17	(-) 45,05	(-) 19,10	(+) 6,72	TEXTURED BRICK
2	(-) 15,69	(-) 44,76	(-) 6,59	(+) 15,85	TEXTURED BRICK
3	(-) 25,79	(+) 46,36	(-) 17,93	(+) 9,16	TEXTURED BRICK
4	(-) 25,76	(-) 48,56	(-) 19,96	(+) 6,63	TEXTURED BRICK
1	(-) 0,88	(-) 32,13	(+) 11,68	(+) 18,20	EXTRUDED IND. BRICK
2	(-) 7,83	(-) 37,87	(+) 3,54	(+) 14,18	EXTRUDED IND. BRICK
3	(+) 6,23	(-) 34,20	(+) 21,32	(+) 36,70	EXTRUDED IND. BRICK
4	(-) 11,37	(-) 41,07	(+) 0,20	(+) 8,69	EXTRUDED IND. BRICK
1	(+) 0,28	(-) 36,49	(+) 15,63	(+) 19,53	MOULDED IND. BRICK
2	(-) 6,97	(-) 44,01	(+) 7,92	(+) 15,54	MOULDED IND. BRICK
3	(+) 7,77	(-) 32,57	(+) 23,10	(+) 36,70	MOULDED IND. BRICK
4	(-) 9,10	(-) 47,10	(+) 6,40	(+) 15,72	MOULDED IND. BRICK

COATING TYPES:
1- Microcrystalline wax in water base.
2- Two- component system based on polyurethane-catalysed hydroxyl acrylic resin.
3- Acrylic copolymer in water base.
4- Acrylic primer in aqueous dispersion and two-system component varnish finish in polyurethane base.

The + sign means that the absolute value found for the specimen coated with graffiti - proofing was higher than the absolute value of the measurement found for the uncoated ceramic specimen.
The - sign means that the absolute value found for the specimen coated with graffiti - proofing was lower than the absolute value of the measurement found for the uncoated ceramic specimen.

DISCUSSION OF THE RESULTS

All the coatings altered specimen tone and brightness, although differences were observed among them depending on the type of brick involved, as depicted in table 4 and discussed below:

- The industrial extruded or “I” and moulded or “A" bricks tend to behave similarly: the pattern of positive (increase) and negative (decrease) signs preceding the differences in

absolute values for each of the tones was the same for most coatings (regardless of their composition).

- Therefore, it may be deduced that regardless of the coating type the variation in tone was of the same nature, i.e. the quantification parameters followed the same pattern, in the two types of industrial brick used in the study.

A general analysis of the RGB colour breakdown in the three types of brick analyzed (textured, extruded and moulded) shows that:

- Of the three primary colours, red-green-blue, red was the one whose absolute value changed most, and always downward (minus sign). The absolute value of blue, on the contrary, always rose (preceded by a plus sign). The absolute value of green varied both upward and downward.
- It may be inferred from the foregoing that the tone of the bricks treated with graffiti-proofing tended to move toward "cooler" or violet hues, due to the rise in the value of the blue and decline in the value of the red component.
- No regular pattern could be observed in green component behaviour across the three types of brick. The absolute values moved upward in the industrial (I and A) and downward in the textured (R) material.
- Luminosity tended to behave more arbitrarily, generally speaking, but declined steeply in textured brick.

The initial conclusion that can be drawn in connection with the material is that the variation observed in the different colour components was not the same in the three types of brick; the textured brick changed tone more drastically than the two industrial types, regardless of the coating used.

Microcrystalline wax coating in a water base:

- Luminosity varied to a greater extent in the textured or "R" brick than in the industrial types, "I" and "A", where this value remained virtually unchanged.
- The variation in the absolute value of the red component, which was negative in all three materials, was greatest in the textured or "R" brick.
- The green component dropped in textured ("R") and climbed in industrial ("I" and "A") brick.
- The blue component increased in all three types of material but to a lesser extent in the "R" brick.
- It may be concluded that the microcrystalline in water base coating caused greater variations in tone and luminosity in the textured or "R" than in the industrial types of brick, "I" and "A".

Two-component system coating, an aliphatic isocyanate (polyurethane)-catalysed hydroxyl acrylic resin:

- Luminosity declined in all three types of material, although the variation in absolute values was greatest in textured or "R" brick.
- The red component decreased in the same proportion in all three materials.
- The green component declined, although not substantially, in the "R" brick, and rose slightly in the "I" and "A" industrial materials.

- The blue component grew in the same proportion in all three types of brick.
- While the two-system component aliphatic isocyanate-catalysed hydroxyl acrylic resin coating was found to cause no substantial variations in any of the types of brick, the changes observed were proportional in the three materials.

Acrylic copolymer in water base coating:
- This coating behaved differently depending on whether the material tested was textured or industrial.
- Luminosity dropped in the textured "R" bricks, and grew in the same proportion in the industrial "I" and "A" materials.
- The red component rose substantially in "R" and declined in the same proportion in "I" and "A".
- Conversely, the green component decreased proportionally in the "R" brick but showed a positive value in the "I" or extruded variety.
- The blue component climbed in all three materials, but not in the same proportion; in fact, the increase was substantially larger in the industrial types, "I" and "A".
- The acrylic copolymer coating was observed to affect the textured and industrial materials in markedly different ways. The former showed a larger quantitative change in the colour components.

Acrylic primer in aqueous dispersion with a two-component system varnish finish in a polyurethane base:
- Luminosity decreased in all materials, although more notably in the textured or "R" type brick.
- The red component fell in the same proportion in all three materials.
- The green component declined considerably in the textured or "R" type brick, remained stable in the "I" or extruded brick and rose in the "A" type or moulded brick.
- The blue component grew very little in the "R" and "I" bricks, and to a greater extent in the "A" type or moulded brick.
- The conclusion to be drawn here is that the acrylic primer in aqueous dispersion with a two-component system polyurethane base varnish finish prompted irregular variations in the colour components in the three types of materials, following no discernible pattern on the basis of the nature of the brick (textured, extruded or moulded).

FINAL CONCLUSIONS

The surface of brick facing changes tone when coated with graffiti-proofing. The characteristics of this variation depend less on the type of coating than on the properties of the underlying material.

Conclusions respecting the brick material
- Textured brick is much more likely to undergo colour change than industrial brick, whose variations in tone are less perceptible, though nonetheless quantifiable.
- On the grounds of this result in connection with the material, it is suggested that: Industrial brick (normal extruded facing brick or normal moulded facing brick, indistinctly as there are no significant differences between them) is recommended as the

more suitable choice of material for brick facades that are to be coated with graffiti-proofing.

Conclusions respecting the graffiti-proofing

- Microcrystalline wax in water base coatings has a greater impact on tone and luminosity in textured than industrial brick.
- Two-component system aliphatic isocyanate-catalysed hydroxyl acrylic resin coatings change the tone in all three materials, but the variation is only slight and essentially proportional in the three types of brick.
- Acrylic copolymer in water base coatings affect textured brick much more intensively than industrial materials. The alteration is proportionally larger in the former type of brick.
- The colour variations brought about by coatings consisting of an acrylic primer in aqueous dispersion and a two-component system varnish finish in a polyurethane base is indistinctly irregular in the three types of material (textured, extruded or moulded).
- On the grounds of these results for the graffiti-proof coatings, it is suggested that:
- For brick facade surfaces where the type of brick has already been determined and is in need of graffiti proofing, the coating of choice should be:
    - For textured materials: aliphatic isocyanate-catalysed hydroxyl acrylic resin coatings, which causes the least variation in the absolute value of three of the four colour components.
    - For normal extruded facing brick: microcrystalline wax in water base coatings, given that in the four colour components analyzed, two of them showed the smallest deviation in the absolute value after treatment with this coating, and the other two colour components showed the smallest deviation with respect to the smallest value.
    - For normal moulded facing brick: two-component system hydroxyl acrylic resin, since more of the colour components of this material are closer to the smallest deviation in absolute values observed in the study.

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