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Instituto de Pesquisas Tecnológicas

TECHNICAL REPORT NR. 52 711

Nature of Work: Technological Testing on artificially colored stone

Client: Royal Marble & Granite Ltd.

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Título: Ensaios tecnológicos em rocha colorida artificialmente.

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Sponsor:

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Summary

Tests were carried out on a sample of polished tiles which had undergone the process of intercrystal coloring, as well as titles which had not undergone the process, of a stone called “Granito Cinza Corumbá”(CorumbáGrey Granite), supplied by the client
The tests consisted of: physical indexes, resistence to flexion whith weights on 4 points, Amsler Abrasive wear, alteration by chenical products and exposure to artificial light and water in condensation and ultraviolet chamber.
THE OBTAINED RESULTS, SHOW THAT, FOR THE ANALYSED SAMPLE THE PROCESS OF “INTERCRYSTAL COLORING” HAS NOT ALTERED THE PHYSICAL AND MECHANICAL PROPERTIES OF THE MATERIAL.

Suggested Key Words:

Testing - artificial coloring - alterability - granite - Royal

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Nature of Work: Technological testing on artificially colored stone

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1. INTRODUCTION

Regarding the Client's request, mentioned in the Budget Letter DIGEO/LPTR-095/01 of 04.24.01 and the fax of 05.14.01, the Laboratory of Petrology Stone Technology, of the Stone Engineering Group, of the Geology Division of this Institute, has carried out tests of technological nature on samples of stone designated as “Granito Cinza Corumbá” (Grey Granite Corumbá), in its natural state as well as in its artificially colored state (reference LPTR 137/01). The sample was supplied by the Client by means of 7 40x40x2cm artificially colored tile, polished on both sides and one 40x40x2cm natural tile polished on one side.

2. OBJECTIVES

The objective of the present study is to characterize the stone sample of tiles, aiming at the process of the efficiency of the artificial coloring process, declared by the client as “intercrystal coloring”.

3. MATERIAL AND METHODS USED

Polished tiles made of a stone commercial known as “Granito Cinza Corumbá” (Grey Granite Corumbá) were tested. Its natural color is grey whereas the artificially colored sample is purplish pink.

The test used were: definition of physical indexes, flexion with weights on 4 points, alterability by means of chemical agents commonly used in cleaning products of domestic use, alterability by means of exposure to artificial light and water by cycles of condensation and irradiation of ultraviolet rays and Amsler erosion, as described below.

3.1. Definition of Physical Indexes

The physical indexes were determined by means of ten samples of “natural” stone and “artificially colored” stone according to the DIGEO-LPTR-PE-017 procedure, based on the NBR 12766/92 norm - “Stone for Revetment Definition of the apparent specific density, apparent porosity and apparent absorption of water” of the Associação Brasileira de Normas Técnicas (Brazilian Association of Technical Norms) ABTN. The samples were prepared with diamond-tipped saw blades. The polished face was also abraded with diamond-tipped blades.

3.2 Testing for Flexion

The testing for flexion was carried out on twelve rectangular samples, in their dry and saturated states, in accordance with the DIGEO-LPTR-PE-027 procedure “Resistance to Flexion with weights on four points” based on norm C 880/98 - “Standard Test Method for Flexural Strength of Natural Building Stone” of the American society for Testing and Materials ASTM.

3.3 Testing for Alterability

The testing was carried out “artificially colored” slabs only, according to the DIGEO-LPTR-PE-047 procedure “Alterability by Chemical products, based on attachment H, norm NBR 13.818/97: “Ceramic slabs for revetment - Specification and Testing Method”, of ABTN; non-ionized water was also used as a reference.
Areas of approximately 10x10 cm were selected from seven polished slabs of 20x20cm to take forty measurements of degree of polishing using the Sanwa Kenma polishing measurer, model IG 330. After these measurements the slabs underwent an alterability test.

Agent Used	Concentration	Time of Exposition
Acetic acid	5% density	168 hours
Potassium Hydroxide	10% density	168 hours
Citric acid	3% density	6 hours
Ammonium Hydroxide	10% density	6 hours

TABLE 1 Chemical agents used and time of exposition for alterability testing.

After the testing and cleaning of the slabs, new measurements of the degree of polishing were taken to determine the possible harm caused by the use of the above agents.

3.4 Artificial Light and Water Exposure

The procedures to expose the “artificially colored samples” to artificial light and water, were based on the ASTM G 53/89 method guidelines “Recommended Practice for Operating Light and Water Exposure Apparatus (Fluorescent UV-Condensation Type) for Exposure of Nonmetallic Materials”, according to the Technical Report DEC/AMCC nr 52666/01, ATTACHMENT A.

Four 15x10cm tiles were sawed from a 40x20x2cm tile. Three of them (A, B and C) underwent the test and the fourth (D) was used as reference. (PICTURE 1)

The testing for accelerated ageing consisted of 4-hour cycles of ultraviolet radiation (UV) at 60 degrees Celsius and of four hours of condensation at 50 degrees Celsius. The evaluation of the effects was carried out at intervals of 100 hours and after the exposure. The test samples were photographed before and after the final exposure.

PICTURE 1 - Samples used in the artificial light and water exposure test.

The C-UV chamber "Accelerated Ageing System for Non-Metallic Materials", of the COMEXIM (pictures 1 and 2) and ultraviolet-B fluorescent lamp bulbs, type TL 40W/12RS, manufactured by PHILIPS. The mains peaks are 313nm and 370nm (UVB), with radiance of 0,850-90 and 0,30 Wm2/nm, respectively.

3.5 Amsler Test for Abrasion

The Amsler test for abrasion was carried out on two test samples taken from the "artificially colored" sample slab, according to the guidelines of the NBR 12042/92 norm "Inorganic materials Determination of erosion by abrasion", of the ABNT, in accordance with the Technical Report DEC/AMCC nr. 52.097, ATTACHMENT B.

4. RESULTS

4.1 Definition of Physical Indexes

The results of the physical indexes according to the Testing Report nr. 881.664, are shown on Table 2, below.

STATE OF STONE	APPARENT SPECIFIC DENSITY		POROSITY	ABSORTION
	Dry (kg/m3)	Saturated (kg/m3)		
Natural	2.675± 6	2.682± 6	0,78 ± 0,03	0,29 ± 0.01
Artificially Colored	2,685 ± 4	2,692 ± 4	0,68 ± 0,01	0,25 ± 0,00

TABLE 2 - Results of the physical indexes definition for the Corumbá Grey Granite sample (Granito Cinza Corumbá), (LPTR 137/01), average and standard deviation for 10 test samples.

4.2 Resistance to Flexion

The results of the testing for the resistance to flexion (ASTM C 880/98) for the “Artificially colored Corumbá Grey Granite” (LPTR 137/01), shown in the Testing Report nr. 881.664, can be found on TABLE 3.

The ruptured surfaces showed practically the same color in all of its extension, indicating that, in the tested samples, the coloring process penetrated the whole tile.

STATE OF TEST SAMPLES	TENSION OF RUPTURE, R	
	(kgf/cm2)	(MPa)
Dry	87,6 ± 13,1	8,59 ± 1,28
Saturated	81,2 ± 6,5	7,97 ± 0,64

TABLE 3 - Results of the testing for resistance to flexion “Artificially colored Corumbá Grey Granite” (LPTR 137/01), average and standard deviation for test samples.

4.3 Testing for Alterability

The results of the testing for alterability of the chemical products, for the "Artificially colored Corumbá Grey Granite" (LPTR 137/01), shown in the Testing Report nr. 881,664, can be found in the TABLE 4, below.

CHEMICAL AGENTS USED	AVERAGE POLISH OF 10X10CM AREA		MACROSCOPIC EFFECT AFTER TESTING
	BEFORE TESTING	AFTER TESTING	
Potassium Hydroxide (densitymore intense concentration 10%)	81 ± 3	79 ± 6	Enhanced color, making it
Acetic Acid (density 5%)	87 ± 3	81 ± 4	**No changes after cleaning**
Citric Acid (density concentration 3%)	88 ± 3	87 ± 5	**No changes.**
Ammonium Hydroxide (density concentration 10%)	87 ± 2	86 ± 5	**No changes.**
Filtered and Non-Ionized water	81 ± 4	81 ± 5	**No changes.**

TABLE 4 Results of the testing for alterability of the chemical products, for the "Artificially colored Corumbá Grey Granite" (LPTR 137/01), finalized in 05.29.01.

4.4 Exposure to Artificial Light and Water

After 400 hours, the face exposed to ultraviolet light had its color slightly altered to a lighter tone. After 600 hours, which are equivalent to approximately 2 years of exposure, the effect was still slightly altered.

4.5 Amsler Test for Abrasion

The “artificially colored” sample showed erosion by abrasion of 0,86 mm after a 1,000m course. The color of the eroded face of the sample remained unaltered, which confirms the good penetration of the artificial coloring in the stone.

5. CONSIDERATIONS

It is clear that the process penetrated the stone as a whole, that is, it is not concentrated only close to the surface of the tile. The slight decrease in porosity and absorption of water registered between the “natural” material and the “artificially colored” one, may be due to the “intercrystal coloring” process.

As the Amsler Testing for Abrasion was carried out on the “artificially colored” sample, it may said that the intercrystal coloring process penetrated the stone as a whole and that it was not affected by the heat produced during the process.

The technological tests hereby described and commented show that according to the obtained results, the “intercrystal coloring” process has not damaged the physical and mechanical properties of the natural material.

São Paulo, 1st August 2001.

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The Technological Research Institute (IPT) originated from an aggregated nucleus of the São Paulo Polytechnic School. This nucleus was called Gabinete de Resistência dos Materiais (Material Resistance Department) and it was founded by Professor Francisco de Paula Souza in 1899. In the beginning, the main objectives were to support this school's teaching department and develop a testing program aiming at determining the principal physical, chemical and mechanical characteristics of the materials in current use in constructions. In 1931, under the supervision of Professor Ary Torres, the Department was officially denominated Laboratório de Ensaios de Materiais (Material Testing Laboratory). This new name symbolized a significant restructuring of the former department characterized by the renovation and addition of technical apparatus, the increase and selection of new staff, the division of labor into specialized sections and, most important of all, by staff progressively working full time.

The quick expansion of the Laboratory's activities justified its transformation into a Technological Research Institute, annexed to the Polytechnic School in 1934, when the São Paulo University was also founded.

IPT then started to create new areas of technological qualification playing a growing role in several fields: in the development of technological research; in the shaping of a human resources department; in the organization of a legal metrology system and of systems of industrial standards; in the creation and development of a center of technological documentation; in the control and protection of trademarks and patents; and in the acquisition and diffusion of technological information.

The development of the Brazilian industrialization process, accelerated by the Second World War, led the country to invest heavily in the building of huge dams and hydroelectric plants, highways, bridges, government buildings and low-rent housing, etc.

All this effort required an ample participation of IPT and its transformation into an autarchic entity of the State of São Paulo in 1944, making it possible to dynamize this participation, straightening the cultural links with the Polytechnic School and the São Paulo University.

One of the most significant characteristics of IPT´s history is its natural development process, be it in terms of premises or human resources. Each period of its existence has reflected, above all, the development of the country. In 1976, the IPT became a state company denominated Instituto de Pesquisas Tecnológicas do Estado de São Paulo S.A. (Technological Research Institute of the State of São Paulo) IPT. Nowadays, its human and instrumental resources are divided into thirteen technical units: Civil Engineering Department, Department of Economics and System Engineering, Geology Department, Mechanics and Electricity Department, Metallurgy Department, Forestry Department, Chemistry Department, Department of Transportation Technology, Department of Computer Studies and Telecommunications, Leather and Footwear Technological Center, Center of Technological Information, Center of Technical Certification and Center of Technological Improvement

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