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CAIS DAS COLUNAS' PRE-DECONSTRUCTION (1997) DIAGNOSIS

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Abstract

The Cais das Colunas is a limestone quay erected, after the great earthquake of 1755, in the Royal Square of the Portuguese capital. Due to the expansion of the underground lines, the coastal monument was partially removed in 1997, in order to construct a tunnel beside its foundations. On the summer of 2008 the historic quay was finally reconstructed.

The purpose of this article is to present the main results of the studies carried out before the deconstruction, when the main pathologies were identified, classified and mapped. The effects to the weathering forms of the quay, of its stone material heterogeneity and of the environmental conditions, of this particularly polluted coastal area, are also discussed.

Key-words

Cais das Colunas; diagnosis; Lisbon; stone pathologies; weathering forms.

Introduction

The Cais das Colunas is a XVIIIth century limestone pier with two columns. It is located in the border of the Tagus River (Figure 1) and integrates the Terreiro do Paço (the Royal Square of the historical centre of Lisbon, National Heritage since 1910) and the historical downtown of Lisbon, also known as Baixa Pombalina (Figure 2). The quay, erected after the great Lisbon earthquake of 1755, is an historical place and tourist mark of the Portuguese capital.

The Royal Square and Cais das Colunas were, for various decades, the noble entrance of the city of Lisbon. From the last years of the XIXth century until 1908, date of the regicide, there arrived some royal European families, invited by the Portuguese King D. Carlos (Figure 3). There exist notices of the monument in the periodicals, since 1875, concerning its importance to the social memory and also its state of conservation ["Terreiro do Paço" 1875; Castilho 1899].

Figure 1 - Cais das Colunas, 1996. ACA©

Due to the expansion of the underground lines of the city of Lisbon, the coastal monument was partially removed in 1997, in order to construct a tunnel beside its foundations. On the summer of 2008 the historic quay was finally reconstructed.

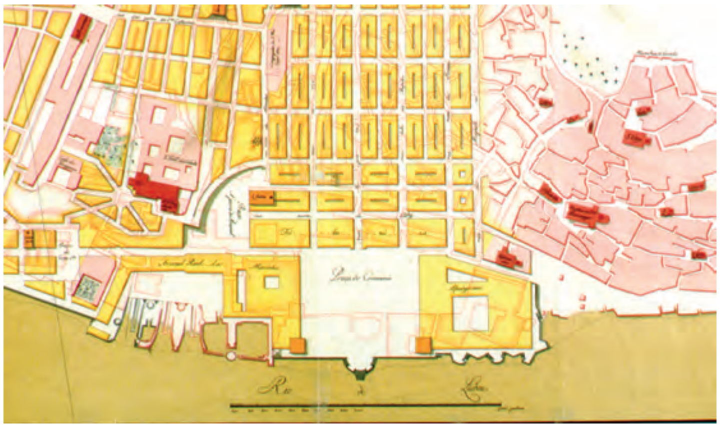

Figure 2 - Plan of the reconstruction of the Baixa Pombalina, 1758

Figure 3 - Arrival of the Spanish monarch, Alfonso XIII, 1903

1. Stone materials

The Cais das Colunas was observed macroscopically, using magnifying glass and binoculars, in order to identify the main stone materials used in its construction and subsequent interventions. It was not possible to map the identified lithotypes.

It were used various compact and crystalline Cretaceous limestones, some with abundant fossils, such as lioz limestone, varying its tone from white to pink. There are also limestones from inferior lithologic levels, such as the alveolar limestone or the stylolitic limestone.

2. Typified pathologies and its mapping on east and west elevations

Before the deconstruction intervention, in 1997, the main pathologies were identified, classified and mapped. Trough macroscopic observation and using, in some cases, binoculars, were identified and classified 17 distinct stone pathologies and others related with mortars and metallic elements. The most significant of east and west elevations, in terms of occurrence, were mapped grouping the pathologies in four maps: Map I: outburst; cracking; fissure; Map II: alveolization; differential degradation; erosion of edges and vertices; concretion; Map III: biological colonization – molusc; biological colonization – algae and lichen; and Map IV: chromic alteration; metallic elements; lack of mortar; cement mortar.

2.1. Map I

The Map I (Figure 4) registers pathologies related with loss of material or its break. It were considered outburst (complete loss of part of stone material), cracking and fissure.

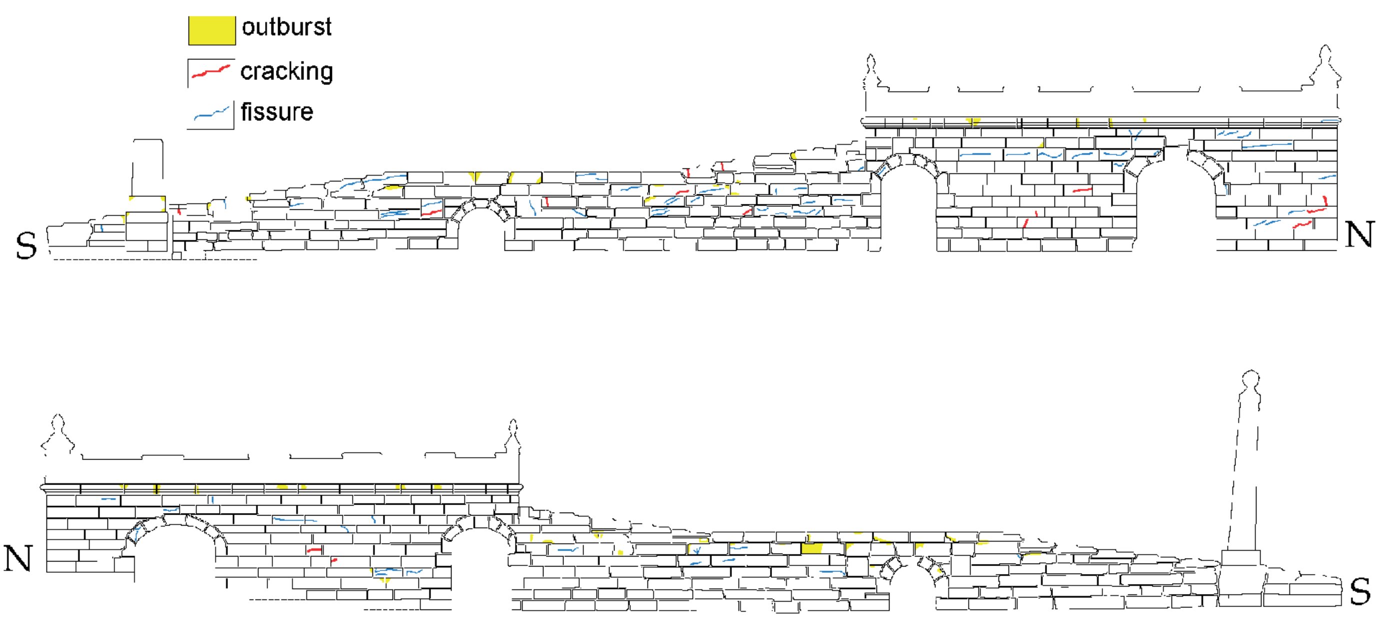

Figure 4 - Cais das Colunas' weathering mapping, Map I, 1997. ACA©

2.2. Map II

The Map II (Figure 6) registers concretion, from biological origin, and variations of erosion, like erosion of edges and vertices, alveolization or alveolar weathering. The last ones occur due to the rocks' structural and compositional heterogeneity (Figure 5).

Figure 5 - Cais das Colunas, 1996. ACA©

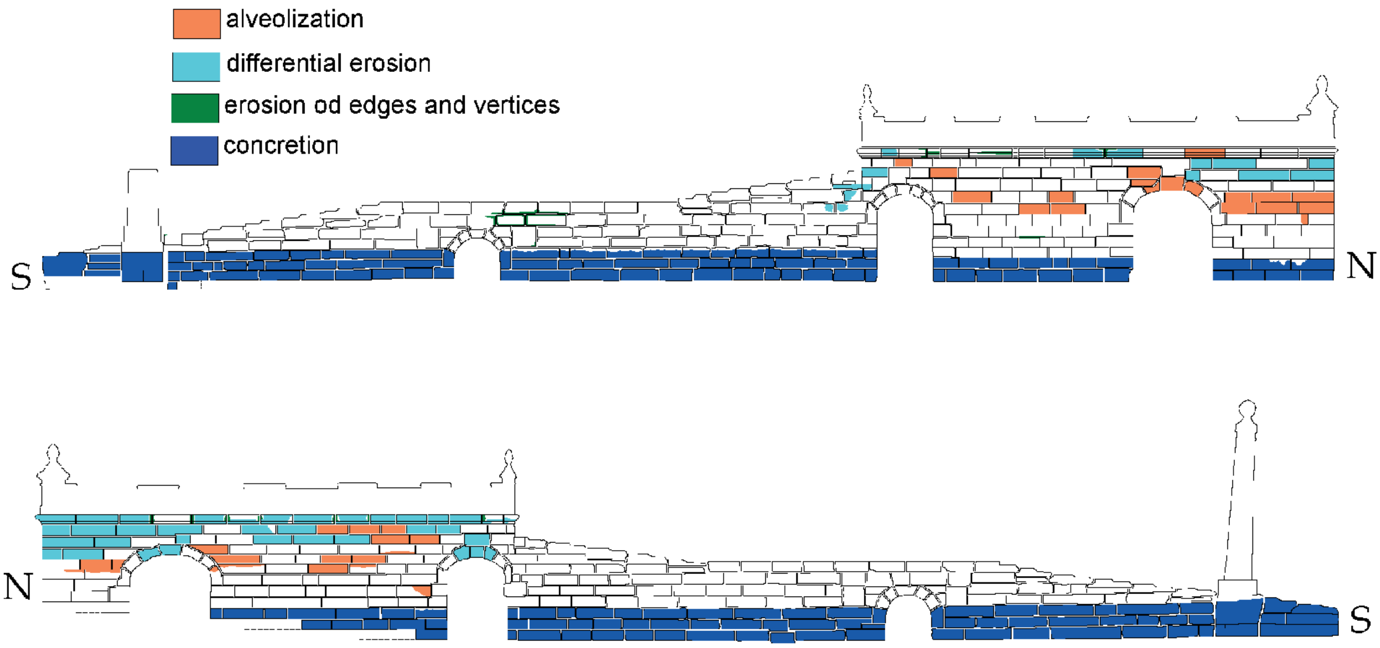

Figure 6 - Cais das Colunas' weathering mapping, Map II, 1997. ACA©

2.3. Map III

The Map III (Figure 7) registers biological colonization, distinguishing molusc (barnacles and mussels) and algae and lichen. The biological colonization leads to the appearance of dirt on the surface of the stone.

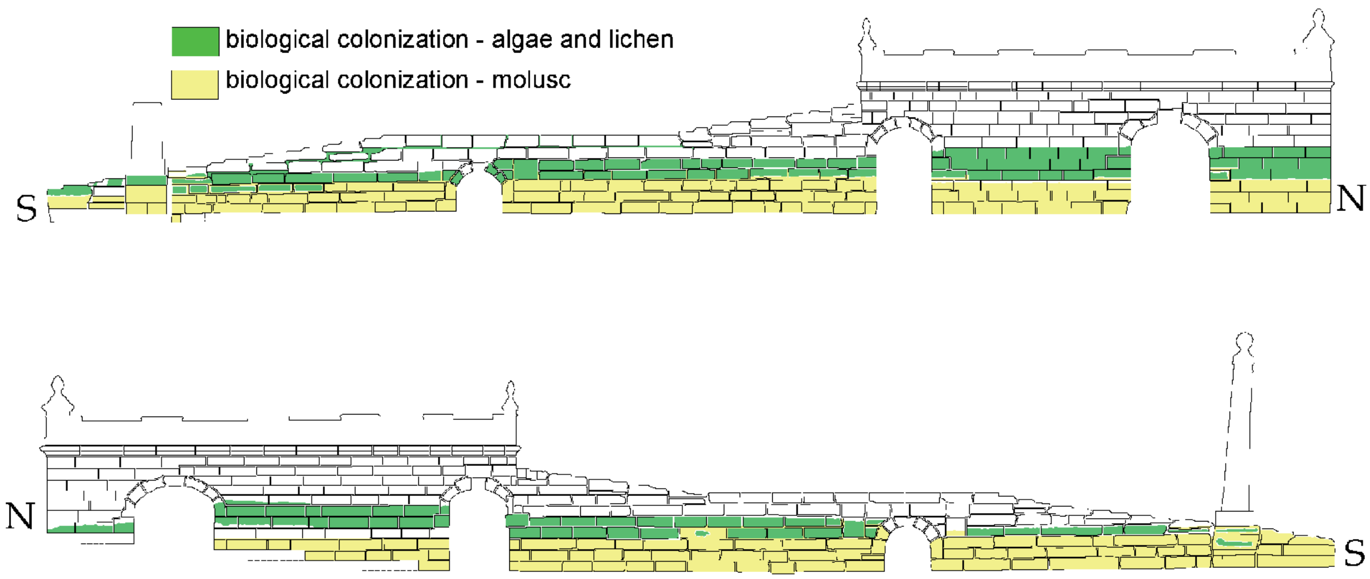

Figure 7 - Cais das Colunas' weathering mapping, Map III, 1997. ACA©

2.4. Map IV

The Map IV (Figure 10) registers chromic alteration of the surface of the rock (Figure 8), presence of oxidized metallic elements (Figure 9) and pathologies related with mortars. It were mapped the presence of cement mortar at the joints and the lack of mortar (Figure 8). The late one was detected especially at the area subjected to variation of the level of the river water due to tides.


Figure 8 - Cais das Colunas, 1996. ACA©

Figure 9 - Cais das Colunas, 1996. ACA©

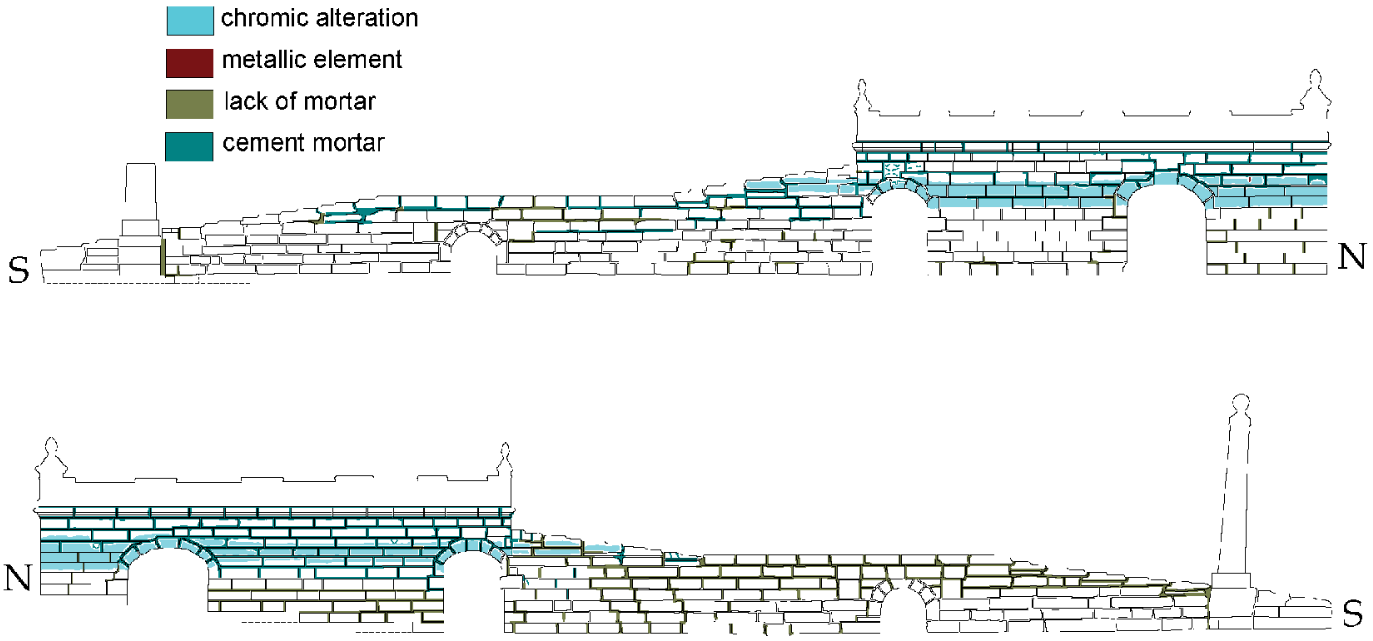

Figure 10 - Cais das Colunas' weathering mapping, Map IV, 1997. ACA©

3. Interpretation

The major agents of stone decay in monuments are air and water. These become much more harmful the more contaminated, by urban-industrial pollutants, they are. Pollution acts as a catalyst, accelerating physical and chemical weathering damage.

Water is indirectly involved in other processes of disintegration, such as the crystallization of soluble salts and biological activity. Water, in its various forms, such as rainfall, condensation or rises by capillary action, is the main cause of deterioration of stone material, the main agent of degradation of monuments in stone. The harmful action of water is enhanced when it carries salts or pollutants. Successive cycles of dissolution and crystallization of salts transported by water, which rises by capillary action, result in the weakening of the material.

Physical actions cause the breakdown of the rock. Are involved in this kind of process: water, wind, insolation and vibrations.

The chemical action of water, as the dissolution of calcium carbonate, is increased when the water is sour by the action of contaminants, as are the cases of nitrogen oxides and sulphur dioxide.

The biological actions can influence stone material both physically and chemically. Chemically, trough reactions that turns substrate into other substances and physically, by the effects of penetration and movement which, cumulatively, with the cycles of wetting-drying generate loss of cohesion of the top layer of stone material.

The monument is subject to several adverse actions: (a) marine aerosol; (b) is partially submerged in polluted water; and (c) is subject to high levels of pollution, shock and vibration due to road traffic and the river water.

It were identified three distinct zones, of weathering damage, on the basis of the river levels, whose degradations effects, but not degree of damage, in both elevations, are very similar: Zone I is always or almost always submerged; Zone II is the one that undergoes cycles of wetting-drying; and Zone III is always free of the river water.

The pathologies identified and mapped on Zone I are those related primarily to the biological actions by the infestation of algae, lichens and molusc (barnacles and mussels) (Map III, Figure 7) and concretions (Map II, Figure 6). The biological colonizers are responsible for mechanic and chemical actions, direct and indirectly, through synergistic interactions ones with the others. Acids segregated by lichens attack chemically stone material. In general, biological colonization leads to the appearance of dirt on the surface of the stone, producing chromic alteration. In the present case, this is aggravated by the deposition of the river water pollutants.

The Zone II evidences particularly chromic alteration and lack of mortar (Map IV, Figure 10). The late one is most evident on the west elevation.

The Zone III major weathering forms are erosion, so differential erosion that alveolization (Map II, Figure 6), and cement mortar (Map IV, figure 10). Both erosion forms are due to the compositional heterogeneity of the stone material, and are most noticeable in the west elevation – subjected to intense insolation. The stone material from inferior lithologic levels exhibits different weathering damage. The differential and alveolar erosions can be due to the action of wind and salt crystallization, affecting the structurally weaker areas - the stylolites or alveolar formations, respectively. The crystallization of salts with and their expansion inside the stone pores, result in loss of cohesion of the crystalline material. This process is accelerated by the wind. It is also on Zone III that the deposition of pollutants from the atmosphere occurs.

4. Final remarks

Weathering forms of east and west elevations are clearly correlated with the stone types and microstructure and to its localization on the quay. East and west elevations reveal different degrees of weathering forms, showing wind and solar radiations effects. Are particularly relevant the river polluted water and the biological attacks, but also the air pollutants.

Actually, a Preventive Conservation Program is being prepared. This will include systematic evaluation and monitoring procedures, during 2011. The aim is to evaluate the effects of the marine environment on the weathering of the quays' materials and also predict their future degradation, in order to act preventively. The 1997's survey is assumed as the starting point of the 2011 research project.

Credits

Personnal archive. [ACA©]: figures 1, 4, 5, 6, 7, 8, 9 and 10.
GEO [Gabinete de Estudos Olisiponenses]: figure 2.
AFCML [Arquivo Fotográfico da Câmara Municipal de Lisboa]: figure 3.

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Alexandra de Carvalho Antunes (b. 1971) is Auxiliar Professor (Faculty of Architecture and Arts, Lusíada University of Lisbon).

Doctor in Architecture; Master in Art, Heritage and Restoration; is specialist in Rehabilitation of Built Heritage.

Since 1996, is responsible for studies, and coordination of works of conservation, restoration and rehabilitation. Most relevant: Cais das Colunas, Mosteiro dos Jerónimos, Arco de S. Bento, Santuário de Fátima and ancient buildings of Lisbon's historic quarters. Main clients: Meliobra/ Edifer, Gapres, Mota-Engil and H Tecnic/HCI.

Concomitantly to the docent activities, since 2000, has created and technically and pedagogicaly coordinated various courses: Building Materials and Processes; Conservation, Restoration and Rehabilitation; Pathologies' Diagnosis. Main clients: Cenfic, AECOPS and À Medida/Grupo Recer.

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